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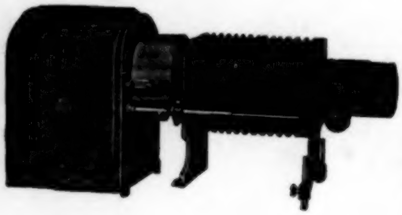

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XXI, No. 3 MARCH, 1921 WHOLE No. 176

MATHEMATICAL ABILITY AS RELATED TO GENERAL INTELLIGENCE.[1]

By B. R. BUCKINGHAM,

University of Illinois, Urbana, Ill.

Ladies and Gentlemen: The nature of mathematical thinking has engaged the attention of many people from early times. Not all their work, nor indeed most of it, has, however, been of a scientific nature. Some of it is as crude as that of the fellow who not long ago proved that a grasshopper hears with his legs. This is how he did it. He took a board, balanced it over a stone, put a grasshopper on one end, and hit the other end with a hammer. The grasshopper jumped off. Then he took the same board and the same grasshopper, pulled his legs off, put him on the same end of the board, and hit the other end of the board with the same hammer. The grasshopper did not jump off. Thus, the experimenter asserted he had proved both positively and negatively that a grasshopper hears with his legs. Perhaps none of the pronouncements in regard to mathematical thinking is as devoid of foundation in fact as this, but some of them are altogether lacking in scientific validity.

In ancient times Plato had perhaps the most exalted notion of mathematics. For example, in Book Seven of "The Republic" he says: "Have you ever noticed that those who have a turn for arithmetic are naturally almost without exception quick at all sciences?" If in this quotation you substitute for "arithmetic" the modern term "mathematics"—and this substitution is reasonably well warranted—then you have the pronouncement that those who are quick in mathematics are quick in all sciences.

Since ancient times not a few treatises have been written on the nature of mathematical thinking. Emphasis has often been

[1]Read before the General Session of the meeting of the C. A. S. and M. T. at Englewood High School, Chicago, November 26, 1920.

placed on the alleged fact that school mathematics differs from so-called higher mathematics both in subject matter and in the human abilities involved. Dr. Rogers, in her monograph on "Tests of Mathematical Ability and Their Prognostic Value,"[2] gives a number of quotations which express this idea. Three will suffice in this connection. Betz, in his article, "Ueber Korrelationen" in the *Zeitschrift fur Angewandt Psychologie,* asserts that "school mathematics has extremely little to do with real mathematical thinking." Poincare affirms that "many children are incapable of becoming mathematicians, to whom, however, it is necessary to teach mathematics." And William Brown in an article on "The Psychology of Mathematics" observes: "There is good reason for thinking that school mathematics and higher mathematics relate to different forms of ability and should be clearly distinguished from one another."

Nevertheless, these writers also contend, according to Dr. Rogers, that "whereas higher mathematics demands special ability, any intelligent child can master the mathematics required in the secondary school, provided he exerts himself earnestly." It is to this statement that I shall particularly direct attention in the following discussion. If the words "any intelligent child" may be taken to mean "any child of average intelligence"—as is no doubt the intention—and if we possess a means of determining the degree of intelligence of children, it is clear that we may determine those who, in the words of our quotation, "can master the mathematics required in the secondary school." If, on the other hand, success in studying mathematics in school depends not only on intelligence—which we may understand to mean general mental ability—but also on special mental abilities of one sort or another, then we shall want to know what these special abilities are and the extent to which each of them is related to success in studying mathematics.

I think you will agree with me that we are continually requiring many high-school and college students to study mathematics who have no aptitude for the subject or whose aptitude is so small that they can never acquire enough mathematics to do them any good. Under the usual circumstances we do not learn this fact until the student, after actually studying the subject, has shown that he can not profit by continuing to do so. It needs no emphasis of mine to convince you that if we could

[2] Rogers, Agnes. "Tests of Mathematical Ability and Their Prognostic Value," p. 3.

know in advance the degree to which each pupil possesses the qualities necessary to success in mathematics, we could save many of them from participating in an undertaking in which they are doomed to failure. We could also relieve our classes of those who absorb so much of our teaching energies to so little purpose.

I may as well say at the outset that the material does not exist for carrying out completely the program which I have just indicated to be desirable. The question of the relation between intellectual ability on the one hand and mathematical ability on the other hand is clearly one of correlation. Data on the general intelligence of any considerable number of school children have only lately become available. As long as we were obliged to rely upon the system of individual testing (as in the case of the Binet-Simon Scale), we could not proceed far. The group tests are hardly more than two years old, and they are no doubt capable of a considerable degree of refinement. It is apparent, therefore, that in expressing the correlation between general intelligence and mathematical ability we are handicapped because of the probable defects of our means of measuring intelligence.

On the other hand, our measures of mathematical ability are by no means above reproach. Those who have related intelligence to mathematical ability have used a variety of measures of the latter trait. Some have used teachers' estimates, others composites of school marks, and still others scores on standardized tests. Each of these three types of measures is faulty.

In the first place, teachers' estimates not only of mathematical ability but also of other school abilities have been brought into serious question because of their failure to square with more objective determinations of ability. This failure of teachers' estimates to correspond with objective measures has been worked out in particular in the elementary school where the required objectivity of the measures is most apparent. There is, however no good reason to suppose that high-school teachers are superior in their estimates of the ability of their pupils. The historical experiment of Starch and Elliott, in which the ratings of a single geometry paper ranged from 28 to 92 indicates that even in a mathematical subject the variation in the judgment of teachers may be exceedingly wide.

In the second place, school marks fail to indicate ability

in mathematics with precision. What they indicate is school success in the subject—which may be quite a different matter. Success is conditioned not only by ability but also by such factors on the part of the pupils as effort, behavior, personality, health, good looks, regularity of attendance at school, and freedom at home from influences inimical to habits of study. Moreover, success in a given subject in the high school is largely expressed in terms of a teacher's judgment. This judgment, as I have indicated, is itself fallible. It is certain that the standards which determine success vary widely among teachers, and that they vary considerably for the same teacher at different times and under different circumstances. For example, a teacher is more lenient when the general level of ability in a class is low. In other words, it is easier for a pupil to obtain a high rating in a poor class than it is in a good class. Both on account of the elements other than those of mathematical ability which condition a pupil's performance, and also on account of the variability of teachers' judgments, school success in mathematics is far from an exact measure of mathematical ability.

I have said that mathematical ability has been represented by teachers' estimates, by school marks, and by standardized tests. I have indicated that in my judgment neither teachers' estimates nor school marks provide a reliable means of measurement. As to standardized tests, they are unquestionably more reliable but their appropriateness or validity is open to question. Here I am distinguishing between two different but related ideas—namely, reliability and validity. An instrument of measurement is reliable to the extent that it yields the same results at different times and in the hands of different persons. It is valid to the extent that it measures the thing it is supposed to measure. In a sense, therefore, validity is more important than reliability. No one, for example, is interested in the reliability with which a test measures something which we do not wish to measure. The point I am trying to make here is that our standardized tests—or at least those which have been used in the correlational studies—do not measure mathematical ability. Most of the tests are in the mathematics of the elementary school. Moreover, neither the measures of ability in algebra nor those of ability in geometry are sufficient measures of general mathematical ability. A composite of algebra and geometry scores, obtained from well-standardized tests, ought to give us an index of mathematical ability which would be both

reliable and valid. It is certain that both algebra scores and geometry scores would correlate highly with scores in general mathematical ability—supposing that the latter could be obtained. Since, therefore, abilities in these two subjects correlate highly with such measures of mathematical ability as we possess, and since they are relatively independent of one another, each of them contributes to the thing we call mathematical ability. My point, however, is that neither one alone is a sufficient measure of it. This could only be true if good algebraists were also good geometrists and vice versa.

With these limitations we shall be obliged to content ourselves with something less than we should desire in the way of evidence on the relation between intellectual ability and mathematical ability. Probably the best measure of mathematical ability has been furnished in Dr. Rogers' monograph to which I have already referred. As a result of her use of a large number of tests, Dr. Rogers selected a battery of six which appeared to have greatest value in measuring the elements of mathematical ability. Three of these are mathematical in content and three of them more closely resemble material usually found in intelligence tests. The mathematical tests are (1) algebraic computation, (2) interpolation (in which the subject is required to insert missing terms in series of numbers), and (3) geometry (in which as a preliminary to the test all the required propositions are stated). The three non-mathematical tests are (1) superposition (which is a measure of ability to grasp spatial relations), (2) mixed relations (in which the subject, after observing the relation between two given words, is to find a fourth which sustains the same relation to a third given word), and (3) Trabue Language (in which the subject is required to insert missing words in given sentences). Dr. Rogers' problem was to find a battery of tests which would enable a school official to tell early in the high-school course what the probable success of a pupil would be in studying mathematics. It will at once occur to you that a test in geometry is not likely to be applicable early in the high-school course. This test, however, as I have indicated, gives the pupil the necessary propositions. They are required to study these propositions before proceeding to answer the test questions. Since the propositions are of a simple nature and time is given for the study of them, and since the questions require no knowledge of geometry other than that furnished in the propositions, it is clear that it is possible to give this test before geometry has

been taken up as a formal subject in the course of study.

Dr. Rogers' tests, when taken in combination, yielded correlations of from 0.60 to 0.90 with school marks. Since, as I have pointed out, school marks measure school success rather than ability in mathematics, it is probable that at least a portion of the difference between the obtained correlation and perfect correspondence would be accounted for by the insufficiency of the measures in the relative series. In other words, if the relative series—that is, the series of school marks—perfectly represented the mathematical abilities of the pupils in question, it is probable that the correlation of Dr. Rogers' battery of tests with school marks would be appreciably higher. Even as it is, these coefficients indicate a marked positive correlation. When corrected for attenuation, they ran up to 0.92 in the Horace Mann School.

I do not know to what extent I may use the terminology of mathematical statistics before an audience of this sort. As to correlation perhaps I ought to say that perfect correlation is represented by 1 and absence of correlation by zero. Perfect inverse correlation is represented by -1. I may add that data, when arranged for computing a correlation coefficient, present two series of measures. If we are—as is usually the case—interested in two characteristics of an individual, we have two measures for each individual, and there are, of course, as many of these measures as there are individuals. One series of measures we call the subject series, and the other the relative series. In what I have just said I have assumed that the measures of mathematical ability constituted the subject series and that the school marks constituted the relative series.

But Dr. Rogers' problem, although allied to the one we are considering, was not identical with it. We desire to know the extent to which mathematical ability and general mental ability are interrelated. Since, however, the battery of Rogers tests probably gives us a better measure of mathematical ability than any other available instrument, it will be important to know the correlation which exists between scores in a group intelligence test on the one hand and the Rogers battery test on the other hand. Search of the literature has failed to reveal any published accounts of pupils tested in these two ways. A few pupils, however, in the Champaign High School were given the Otis Group Intelligence Scale and The Rogers Tests in January, 1920. These tests were administered by the Bureau of Educa-

tional Research of the University of Illinois at the request of the city superintendent. The results were intended to serve his immediate purpose, and they were not organized so that a report could be made in the form which we now have in mind.

There were a number of pupils at the Champaign High School who were failing in algebra, and an attempt was being made to find out whether or not the failure was due to lack of intelligence. It will be interesting in view of the topic which we have under discussion to note that the results did not lend color to the idea that these students were failing because of lack of intelligence. Other unfavorable factors besides low intelligence seemed to be operating. Indeed, lack of mental ability seemed to be present in but a few cases. There were social questions, disciplinary questions, irregular attendance, and unfortunate attitudes present among these students.

For the twenty-seven pupils from whom we had complete returns, the relation between intelligence (as measured by the Otis scale) and mathematical ability (as measured by the Rogers tests) was not as close as we expected. The correlation coefficient was 0.32. Permit me to remind you of the mathematical significance of the correlation coefficient. If we assume that the measures of intelligence are arranged from the origin along the axis of abscissas and the measures of achievement in the mathematical tests from the origin along the axis of ordinates, the line of relation of intelligence to mathematical achievement will have a certain slope to the horizontal. The equation of this line may be expressed as

$$y = a + mx.$$

In this equation m, or the slope of the line, evidently tells us the extent to which increases in intelligence are accompanied by increases in mathematical ability. If $m = 1$, the relationship is evidently perfect, and unit changes in intelligence are accompanied by unit changes in mathematical ability.

The value of m depends upon three quantities: (1) the variability or scatter of the intelligence scores; (2) the variability of the mathematical scores; and (3) a quantity known as r which is a function of the deviations of the intelligence and mathematical scores from their respective averages. This r is the so-called correlation coefficient. In the case we are discussing—namely, the students who were failing in algebra at the Champaign High School—$r = 0.32$. The interpretation of this figure is to be sought through the determination of m, or the slope of the line

of relation. The three quantities upon which, as I have said, the value of m depends are associated according to the equation

$$m = r\frac{\sigma_y}{\sigma_x}$$

where σ_y is the variability in the mathematics measures, σ_x is the variability in the intelligence measures, and r is the correlation coefficient. In this case σ_y equals 1.4 and σ_x equals 1.7. Therefore, $m = 0.26$.

This last figure expressed the fact that, for a unit change in intelligence scores, 0.26 of a unit change in mathematical scores may be expected on the average. Permit me to enlarge upon the meaning of this a little further. I have said that if m (the slope of the line of relation) is 1, the relationship is perfect and the angle which the line of relation makes with the axis of abscissas is 45°. If m is less than 1, the angle is less than 45° and the relation is diminished. In the limiting case in which m becomes 0 and the line of relation coincides with the axis of abscissas, increases in intelligence correspond to no increases whatever in mathematical ability. In other words, you can see that in this case the value of m is about one-fourth. The size of the angle, of course, is considerably smaller than 45°; in fact it is a trifle less than 15°.

It is clear, therefore, that so far as these few children are concerned, their degree of success with the Rogers mathematical tests rests upon causes which have little to do with success in the Otis intelligence test. It is possible, of course, that the Rogers tests do not measure mathematical ability. Personally, I think they do so for high-school children more satisfactorily than any means now at hand. It is equally possible that the Otis Group Intelligence Scale fails satisfactorily to measure general intelligence. The wide usage, however, which this instrument has had, and the general satisfaction which it has given, seem to indicate its value for the purpose for which it was constructed. Again, the small number of cases—namely, 27—makes the results of this correlation of little value unless they are corroborated by evidence drawn from other sources.

I shall give you some of this evidence for what it is worth. Professor Jordan of the University of Arkansas gave the Army Alpha Intelligence Test to freshmen at that University. He also obtained for the same students their university ratings in science, history, modern languages, mathematics, and English.

The correlation of the scores in the Alpha test was highest with the ratings in history, namely, 0.54; and next highest with those in English, namely, 0.52. The correlations with science and modern languages were next in size and the smallest correlation was with mathematics. It was 0.21. This result was obtained from 94 students. When the results on the Alpha test were related to the previous ratings of these students in high school, the correlation with mathematics was again lower than any other, namely, 0.22.

Mr. O. A. Wood, reporting concerning 23 pupils out of a class of 34 who were failures in first-year algebra, gives results of a different order. The Binet-Simon intelligence test and the Rugg and Clark algebra test produced a correlation coefficient of 0.71. Mr. Wood also reports for these students a correlation of 0.999 between teachers' marks and the results of the Rugg and Clark test. He adds, "If the Rugg and Clark tests are trustworthy, then the teacher-marks are absolutely reliable as a gauge of the algebraic ability of this class." It is perhaps worth noting that the author was himself the teacher of the class. It is also worth noting that the correlation coefficient of 0.999 is absurdly out of proportion to correlation between test results and teachers' estimates as obtained by other workers. I am inclined to doubt the correctness of Mr. Wood's coefficients. Even if they are correctly computed, they are, like my own given a few moments ago, carried out on too few cases to be worthy of consideration unless supported by independent evidence. Not only is his coefficient of correlation between intelligence and ability in algebra (0.71) out of line with similar correlations having to do with mathematical abilities, but it is also at variance with the correlation between intelligence and other school subjects. For example, Jordan found that the relation between scores on the Army Alpha Intelligence Test and the average of university marks was 0.485. Colvin obtained for the same relationship at Brown University on one occasion 0.436, and on another occasion 0.394. Again, at the Southern Methodist University, Hunter found a relationship between psychological scores and school grades amounting to 0.52; and Walcott found a correlation of 0.47 between Alpha scores and average ratings at Hamline University.

With further reference to the degree of correlation between scores in tests of intelligence on the one hand and scores in mathematics on the other hand, I submit the following data

drawn from the files of the Bureau of Educational Research. They refer to conditions in the elementary school, the high school and the university.

1. *Elementary school.* One hundred ninety-two seventh-grade children and 156 eighth-grade children at Urbana, Illinois, took the Illinois Examination about a month ago. This examination contains an intelligence test, a reading test, and a rather searching arithmetic test. The correlation between intelligence and arithmetic was 0.33 for the seventh grade and 0.63 for the eighth grade. For the two grades combined it was 0.41.

2. *High school.* Two hundred thirty-five second-year pupils at the Harrison Technical High School, Chicago, took the Terman group intelligence scale and the Chicago intelligence test. The correlation between the results of the Terman test and the average school marks in algebra for the previous year was 0.25. When the results of the Chicago tests were used, the correlation with algebra was 0.26. The smallness of these coefficients might be thought to be due in part to the unreliability of the Terman and Chicago tests as measures of intelligence. A composite of the two tests might be expected to yield a better measure. But intelligence so measured yielded a correlation coefficient of but 0.19.

In the spring of 1919 the Army Alpha test was given to 195 juniors and seniors at the Urbana (Illinois) High School. The correlation between the scores on the Army test and school ratings in algebra was 0.38; that between scores on the Army test and geometry ratings was 0.40.

3. *University.* In March, 1919, the Army Alpha test was given to most of the students then enrolled at the University of Illinois. I have selected at random 110 papers written by freshmen in the College of Engineering. I have related the scores of these freshmen to their university marks in college algebra and calculus. I find the correlation between the scores on the Army test and the scores in algebra to be 0.23. The corresponding figures for the relation between scores in the Army test and ratings in calculus is 0.10.

I think these correlations are sufficient to establish a strong presumption that ability in mathematics—at least such ability as is indicated by success in school—is not as closely related to general intellectual capacity as we are likely to suppose. In general this relationship seems to be such as may be expressed by a correlation coefficient of about 0.40. It leaves plenty of room for causes other than intelligence to operate in pro

ducing success or failure in mathematics. It is consistent, for example, with a full quarter of a given group of pupils being either above average in intelligence and at the same time below average in mathematics, or below average in intelligence and above average in mathematics.

There seems to be much in the success of students in mathematics—and in their failure as well—to countenance the belief that mathematical ability is in no small degree *sui generis*. What we need to do is to carry the investigation further. No group can do this with so strong a prospect of success as can the group represented in this Association. We need to obtain from a number of high-school and college students first, measures of intelligence and second, a series of measures of special abilities—interpolation, analogies, spatial relations, etc. We should then select one or more groups of students having about the same level of intelligence. For each of these groups having substantially the same general endowment, we may from their performance on the tests of special abilities investigate with some success the elements which enter into the thing we call mathematical ability.

This sort of information we should very much like to have because it will have bearing on our administrative procedure. We may thus be placed in a position to know how we may direct a great many students away from a situation in which they are trying to do the impossible.

THE PUBLIC SCHOOLS OF CHAMPAIGN.

By W. W. Earnest,

Superintendent of Schools, Champaign, Ill.

Textbooks.

Our views of what education should be change from decade to decade, and even more rapidly in this period of world upheaval as the real needs of society demand. As new views become generally accepted in the educational world or in any particular field of education, we expect to find and always do find those views reflected in a crop of new textbooks, prepared to present the subjects to pupils in the up-to-date form.

There is probably no other field in which the newer ideas are so sure to appear quickly in book form as in that of education, probably because by its very nature it is handled by persons accustomed to writing and ambitious to take part in advancement.

In no other field is there a more keen or a more clean competition than in that of producing textbooks; first, in the field of authorship in which there are so many hundreds competent to compete that it is worth while for only those who are especially well equipped to enter the contest—and they are subject to the most searching criticism and comparison—

and, second, in the publishing department, in which a surprisingly large number of firms are striving each to secure and present the best list of bo s.

Forty years ago there was a combination of the most of the firms publishing textbooks into a single firm which became known as the school book trust, and for a few years this combination had no equal competition. It was only a few years, however, that this condition lasted. In the very nature of the case, it could not last, because it is so easy for a new publishing house to begin, perhaps with a single remarkably attractive book, and afterward to add others to its list.

From that earlier time has come down an impression, long since a false one, that the cost of textbooks is unreasonably high. As a matter of fact, the prices of these books were about the last prices to advance during twenty years of gradual and a few years of sharply advancing costs. The publishing houses of today are securing so small profits on business that the danger is rather of discouraging their usual enterprise and leaving us with less of their valuable service.

As to the function that textbooks perform in the school system, they may be said to correspond to the tools of the trade in mechanical occupations. Just as a skilled mechanic can still do good work with rather poor tools, so can a highly competent teacher give instruction in any subject with almost any textbooks. This is especially easy in reading, arithmetic and some other simple subjects. However, as any mechanic is much helped by the best of tools, so is any teacher helped by having good textbooks and should have them. In science, geography and history and to some extent in other subjects, texts grow out of date in a few years and should be replaced occasionally, either by thorough revision or by new books.

The cost of textbooks appears great to parents having several children, because it comes all at once. Really, however, the year's bill for a child's books, averaging from two to three dollars per year, some years more and much less other years, or the bill for five children even, would not pay for one cigar a day nor the cheapest movie once a week for the family nor many other small common luxuries. To cripple the school work of the children for lack of the few extra pennies it costs to change once in five or ten years from an old book to one better suited to present uses, is unwise for parents or school board, and not worth complaint.

The selection of textbooks is a function which is assigned in the best school systems to the superintendent of schools. The superintendent, in turn, should depend upon recommendations from the specialists of the high school and the approval of the principal for the selection of high school texts. As to the grade schools, his responsibility is more direct but he makes use of all the help that can be derived from the advice of and conferences with teachers and principals, especially, when these come into substantial agreement.

By state law, a book cannot be adopted for regular use for less than five years. A very few books are so quickly excelled by new ones, especially in a department in which rapid advances are being made, that it would be well to change sooner; more often a book that has proved useful remains in use during ten, fifteen or twenty years. The notion that some people seem to hold that rapid changes are the usual order is as ill-founded as some other wild rumors that occasionally spring up about school affairs.

PAST AND PRESENT PRACTICE IN HIGH SCHOOL LIBRARY BOOK SELECTION FROM THE VIEWPOINT OF A SCIENCE TEACHER.

By Earl R. Glenn,

The Lincoln School of Teachers College, Columbia University, New York.

I. Introduction.
II. The problem.
III. Book selection in 1913-14.
IV. Comparison of past and present practice in book selection.
V. General summary.
VI. Some constructive suggestions.

I. Introduction.

The campaign to provide an adequate library for the modern high school began about 1911. There is much evidence at hand to indicate that this movement is succeeding. It is necessary to refer to a few publications to review the suggestions which have come from the labors of those who believe in the best reading, for the largest number, at the least cost.

The Report of the Committee on High School Libraries,[1] which was published in 1916, gives an excellent summary of the compilations, exhibits, publicity work, and suggestions for future library development, for the year 1915. In the same year the great need for an active propaganda for better secondary school libraries was pointed out as a result of a careful study[2] of 183 libraries in the state of Illinois. It is not necessary to summarize the conditions that were found to exist in the state of Illinois. The facts for this state and others are well known to all who are familiar with the library situation in American high schools. Those who desire specific information for the country as a whole will find it recorded in the Report of the Committee on Problems of High School Libraries[3] for the year 1915.

Progress in the development of the high school library is indicated (1) by the adoption of a tentative report on the standardization of equipment and organization; (2) by state aid; (3) by increased interest of teachers and executives; (4) by cooperation of state inspectors of high schools; (5) by establishment of branch high school libraries; and (6) by the appointment of state advisors.[4]

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[1]Hall, Mary E., "Report of Committee on High School Libraries," Proc. N. E. A. 1916, Vol. liv, Pp. 671-675.
[2]Johnston, Charles H., "The Need for an Aggressive Campaign for Better High School Libraries," Proc. N. E. A., 1916, Vol. liv, Pp. 539-543.
[3]Certain, C. C., "Report of Committee on Probelms of High School Libraries," Proc. N. E. A., 1916, Vol. liv, Pp. 547-558.
[4]Hall, Mary E., Chairman, "Report of Committee on High School Libraries for Year Ending June 30, 1917," Proc. N. E. A., 1917, Vol. xlv, Pp. 559-562.

The results of this labor and discussion which have been in progress for several years are embodied in a report[5] which has been issued by the Committee of the North Central Association of Colleges and Secondary Schools on Library Organization. This report of thirty pages, which is signed by more than a score of educational leaders, should be studied carefully by all teachers and executives who are responsible for the development of the secondary school. We doubt whether this report is receiving the attention that it deserves. It is probable that the suggestions made will have to be repeated many times before the ambitious library program becomes a success.

In giving advice to state high school inspectors this report says:

"It is suggested that a committee be organized in each state to make a survey of library conditions in high schools. To begin the work of standardizing libraries, actual conditions should be studied in relation to the standards given in this report.

"A complete survey should be made including such items as (1) appropriate housing and equipment; (2) professionally trained librarians; (3) scientific service in the selection and care of books and other printed material, and in the proper classification and cataloging of this material; (4) instruction in the use of books and libraries; (5) adequate annual appropriations for salaries and for the maintenance of the library, for the purchase of books, for supplies, and for general upkeep; (6) a trained librarian as a stated supervisor of all the school libraries of the state.

"Based upon this survey, a schedule of systematic library development should be outlined, with definite annual goals to be attained, until all standards have been achieved."

"It is estimated that not more than five years should be required for the complete achievement of standards as given in this report."[6]

II. The Problem.

This study is devoted to a discussion of "scientific service in the selection and care of books and other printed material." If there is or can be any scientific service in the selection of books we desire very much to know how to obtain such service and to use it.

It is only when one attempts to gather facts to aid in intelligent book selection that the layman appreciates the chaotic state of opinions in this field. With the exception of a few book lists which contain about 2,500 titles each, in which certain sections are very much in need of revision and in which some fields are neglected entirely, there is almost nothing to serve as a guide. A school wishing to select a first-class collection of three thousand volumes or more (in carrying out the N. E. A. program) has no standards to guide the judgment of teachers and librarian. This state of affairs promotes the development of an unbalanced

[5]Certain, C. C., Chairman, "Standard Library Organization and Equipment for Secondary Schools of Different Sizes," Proc. N. E. A., 1918.

[6]Pages 4-5. Standard Library Organization and Equipment for Secondary Schools of Different Sizes. N. E. A., 1918.

library because of the aggressive interest of some teachers and the indifference of others, the net result being that pupils leave the high school with no acquaintance with the reliable sources of information in many important branches of knowledge.

III. Book Selection in 1913-1914.

The publication entitled "A Study of the Colleges and High Schools in the North Central Association"[7] which was issued in 1915, gives the statistics on the libraries in approximately one thousand high schools in fifteen North Central States. Not a great deal of attention seems to have been given to the library statistics in this study. However, while they are not entirely satisfactory (we do not believe that such figures can be entirely accurate unless they are furnished as the result of a careful study made by the librarian and faculty), we have found none so extensive that are more reliable. This study to which we refer is based upon the statistics secured (by the authorities of the Association) from the annual reports of 1,000 schools of the North Central Association during the first semester of the school year of 1913-14.[8] Among other questions, the following were submitted to the principals:

Number of volumes in high school library distributed by departments:

English........	History........	Physics........
Botany........	Chemistry........	Agriculture........
Sewing........	Cooking........	Physical Geog........
Zoology........	Latin........	German........
Manual Training........	Education........	Fiction........
Physiology........	French........	Civics........
Mathematics........	Drawing, Art........	Commercial........
Gov't reports........	United States........	State........

Number encyclopedias for high school........

Total number volumes of all kinds added last year........

Number dollars expended last year for books[9]........

These statistics for 1913-14 are used because the schools were operating then under normal conditions. In order to exhibit a few facts on the library situation in the public high schools of fifteen North Central States, we have made a graphical study of the statistics collected by the North Central Association in 1913-14. A brief explanation of the methods used will aid in the interpretation of the figures that are to follow.

In addition to the main title at the top of the figure (Fig. 1) there is a sub-title in almost every case (Fig. 1). Brief explanatory notes will be found in the upper right corner of the figure. The vertical axis in the left has the large unit divided into tenths

[7] U. S. Bureau of Education Bulletin 1915, No. 6.
[8] U. S. Bureau of Education Bulletin 1915, No. 6, Pp. 33 and 100-106.
[9] U. S. Bureau of Education Bulletin 1915, No. 6, p. 34.

by the short black lines. The scale unit used will vary from figure to figure but it is stated in every case in the upper left corner. The quantity represented by the vertical line at the extreme left is given in every case. The subjects which are commonly represented in the American high school library are shown on the horizontal axis in the following order: English, history, fiction (listed as distinct from English for comparison), education, botany, physics, civics, Latin, German, chemistry, physical geography, agriculture, zoology, mathematics, physiology, domestic arts, industrial arts, commercial courses, drawing, French, fine arts, Spanish, general science, physical training, and music.

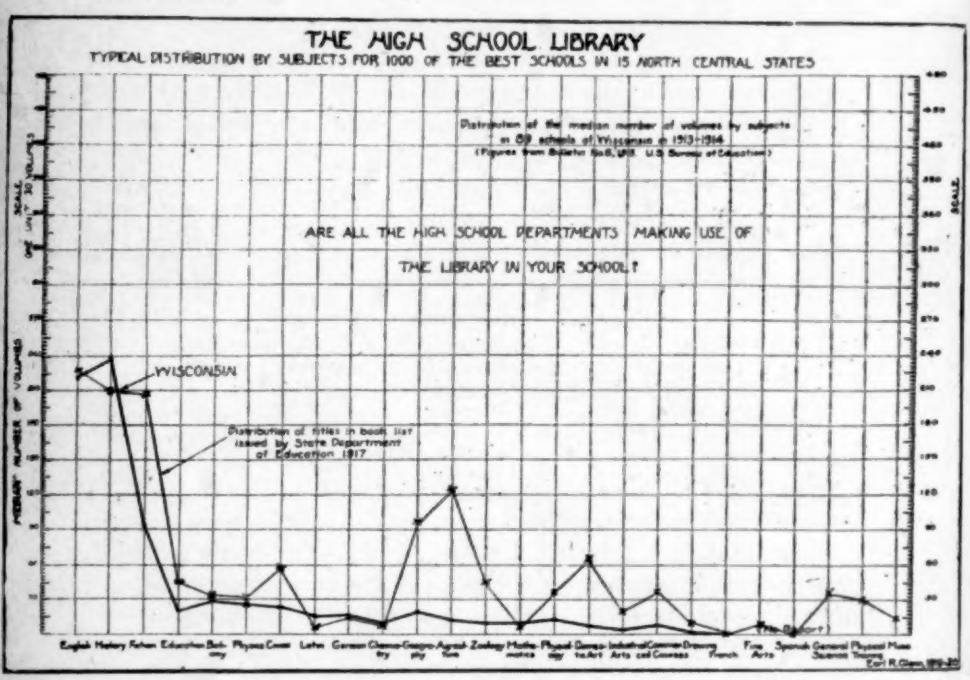


FIG. 1.

Near the middle of some figures there is a question which may serve as a basis of discussion, or in some cases, of an investigation. These questions are only a few of the many important problems which need to be illuminated by carefully chosen facts. The graph is used to show which subjects assume importance.

In these statistics the median has been used for comparison rather than the average or the mode. The median is that point on the scale (number of books, for example) which divides the items into two equal groups. Such a median is found simply

by counting. The term "average" is often used incorrectly. The expression "arithmetic average" means the quotient obtained by dividing the sum of all the items by the number of items. The average has not been used because it gives too much emphasis to the extreme ends, i. e., the small library and the very large library.

In some cases a useful measure of comparison is the mode. This is defined as the scale interval that has the most frequent item. The mode has one advantage. It eliminates the extremes. As a rule the manufacturer of ready-made clothing is interested in the mode, not in the average. The mode, however, is difficult to find by inspection in many cases because no

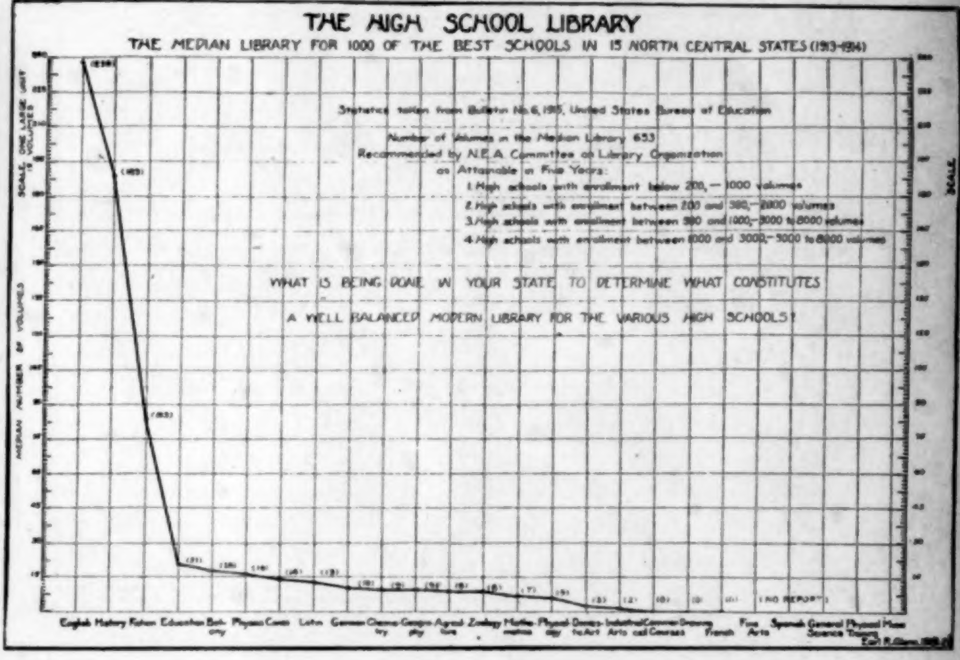


FIG. 2.

particular type stands out. For these reasons, the median is best used in this discussion.

Figure 1 shows the facts for eighty-nine schools in Wisconsin in 1913-1914. The median number of books reported for English is 221, history 238, fiction 92, education 21, botany 28, physics 25, civics 23, Latin 15, German 16, chemistry 9, physical geography 20, agriculture 12, zoology 9, mathematics 9, physiology 13, domestic arts 6, industrial arts 4, commercial courses 7, drawing 1. No report was submitted on the other subjects.

Of the 769 books reported, 451 concern English and history. No other subject reports as many as thirty volumes. The distribution of the titles (this study is interested in the number of volumes, primarily) in the standard book list issued by the State Department of Education is shown for comparison. This distribution leads us to raise the question: To what extent are the various high school departments using the library?

It would help greatly to promote intelligent book selection if the various state authorities would determine the present distribution of references in the schools having modern libraries in charge of trained librarians.

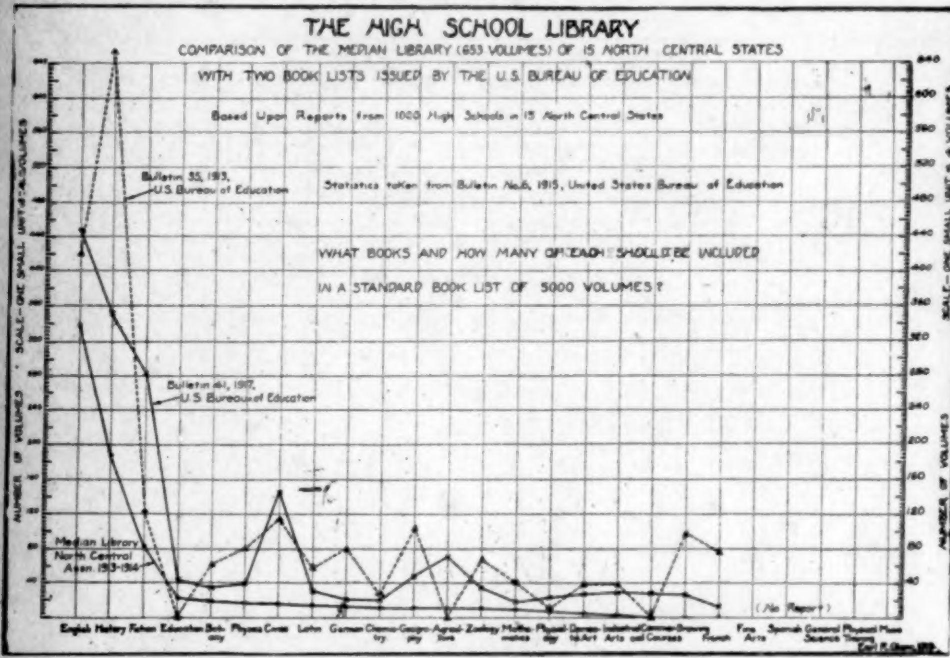


FIG. 3.

Graphs similar to Figure 1 have been prepared for fifteen states and for schools of six different sizes. The curves are similar in every case. One of two conclusions must be drawn here: The individuals who furnished the data to the officers of the North Central Association did not furnish the facts; or most of the reference books deal with English and history. If the first possibility is true, careful studies should be made by the school library people; if the second possibility is true, something should be done to build up well-balanced collections of references.

Figure 2 shows the median library for all of the schools reporting. This collection of 653 volumes is distributed here by subjects. About 78 per cent of this list of 653 books are devoted to English and history. A very conservative interpretation of the report of the N. E. A. Committtee on Library Organization would give:

(a) For schools with an enrollment below 200 pupils, 1,000 volumes.
(b) For schools with an enrollment of 201-500 pupils, 2,000 volumes.
(c) For schools with an enrollment of 501-1,000 pupils, 3,000 to 8,000 volumes.
(d) For schools with an enrollment of 1,001-3,000 pupils, 5,000 to 8,000 volumes.

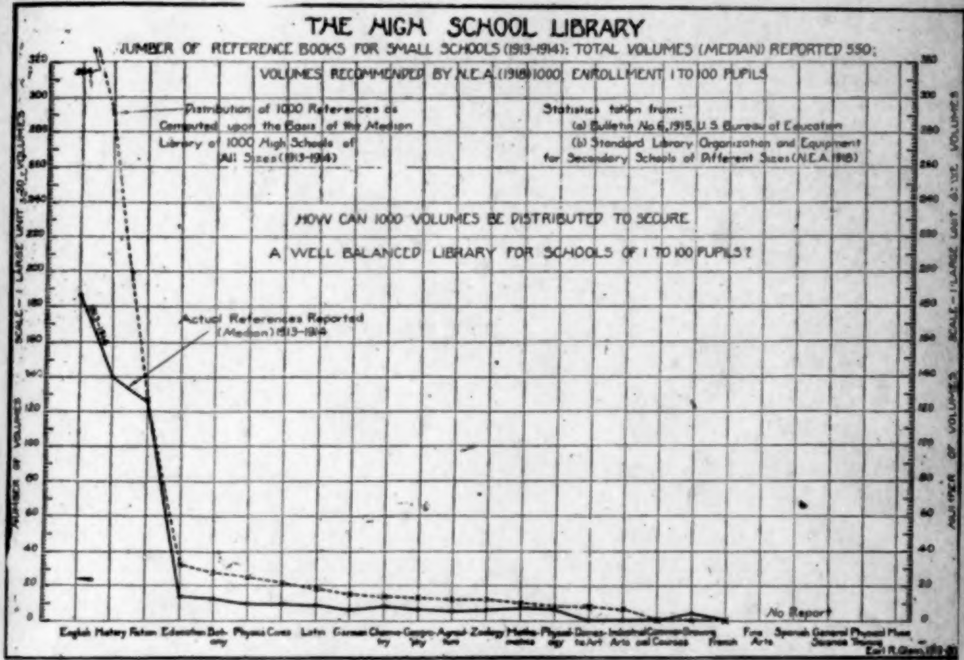


FIG. 4.

Figure 3 gives the comparison of the median library of 653 volumes, and the number of titles per subject in two standard book lists issued by the United States Bureau of Education. Several interesting variations appear here.

IV. Comparison of Past and Present Practice in Book Selection.

In order to compare the distribution of references as reported in 1913-14 with the distribution in vogue in 1919-20, we sent out the following letter and questionnaire to the schools listed in the "Directory of High School Librarians," which was com-

piled by Helen S. Babcock and published in the July, 1919, issue of the *Library Journal.*

Report from The..Library

Subject	**Number of books (Not titles) for**	**Number of pupils taking this subject**	**Ideal Distribution for your school* (see note below)**	
English				
History				
Fiction				
Education				
Botany				
Physics				
Civics				
Latin				
German				
Chemistry				
Geography				
Agriculture				
Zoology				
Mathematics				
Physiology				
Domestic Arts				
Industrial Arts				
Commercial Courses				
Drawing				
French				
Fine Arts				
Spanish				
General Science				
Physical Training				
Music				

Please answer the following questions:

1. **What is the total number of references (not titles) in the library?........**
2. **How many pupils are enrolled in your school?..............................**
3. **How many books were added to the library during the past school year?..**
4. **What sum was spent for books last year?**
5. **How much should be spent each year for books in your school?............**

***This list (see table below) shows the approximate number of volumes recommended by the N. E. A. Library Committee for schools of different sizes. This program is regarded as attainable in five years.**

By use of the blanks given above will you distribute the volumes recommended for a school of your size to obtain what you consider the "ideal" distribution for your type of school?

1-100	**pupils—1,000 volumes**	**301-500**	**pupils—4,000 volumes**
101-200	**pupils—2,000 volumes**	**501-1,000**	**pupils—6,000 volumes**
201-300	**pupils—3,000 volumes**	**1,001 and above**	**—8,000 volumes**

Date.......................... Signed..................................Librarian. No...............

All information furnished will be regarded as confidential and will not be made public except in general terms. Kindly mail the reply to Earl R. Glenn, 646 Park Ave., New York City.

About one hundred and fifty replies were received from high school librarians. Several of these reports were not complete so that about one-third of them were not used in this study. The number of reports used are listed below:

Enrollment	Number of Reports
1-100	3
101-200	8
201-300	11
301-500	14
501-1,000	27
1,000 and above	37
Total	100

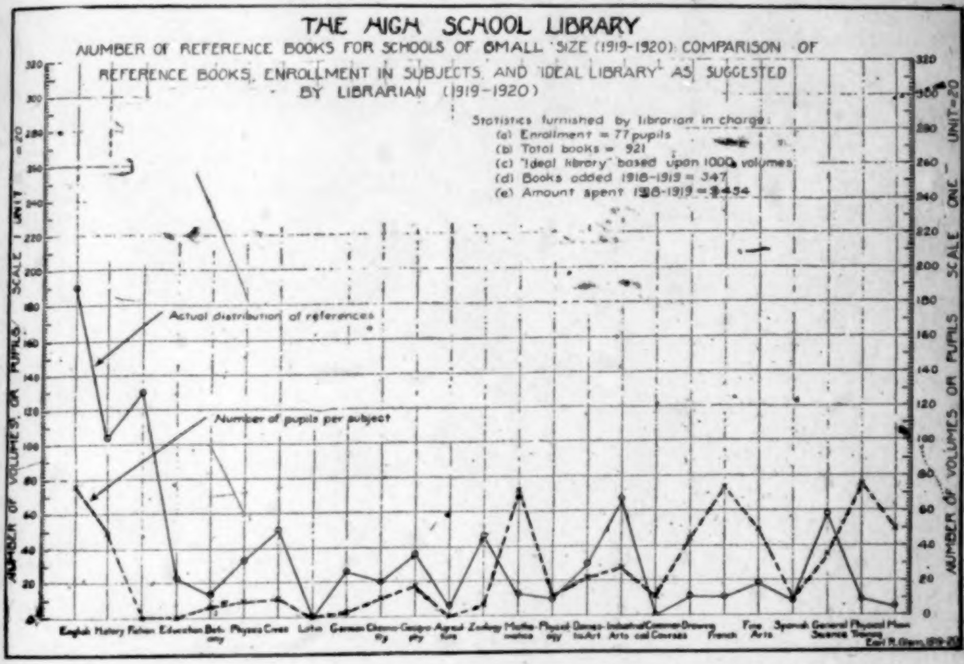


Fig. 5.

The figures submitted by these librarians in various sections of the country have been examined carefully and the most important facts are set forth in the graphs and tables which follow:

Figure 4 shows the median library of 550 volumes for the small school (1913-14) with an enrollment of 1 to 100 pupils. Assuming that this median could be raised to one thousand volumes in 5 years in carrying out the suggestions of the Library Committee, and that past policies in book selection continue to operate we have computed the distribution of the 1,000 references upon the basis of the actual median library reported by

1,000 schools, in 1913-14. This distribution is shown by the broken line.

Figure 4 should be compared with Figure 5, which sets forth the situation in a small school (1919-20) which is known to have a competent librarian and a faculty interested in the high school library. Several variations from the practice of 1913-1914 are shown. The distribution by subjects is much more uniform; there is no decided increase in the English references; Latin references do not appear; German, French and Spanish are represented; and science, domestic arts and industrial arts receive some attention.

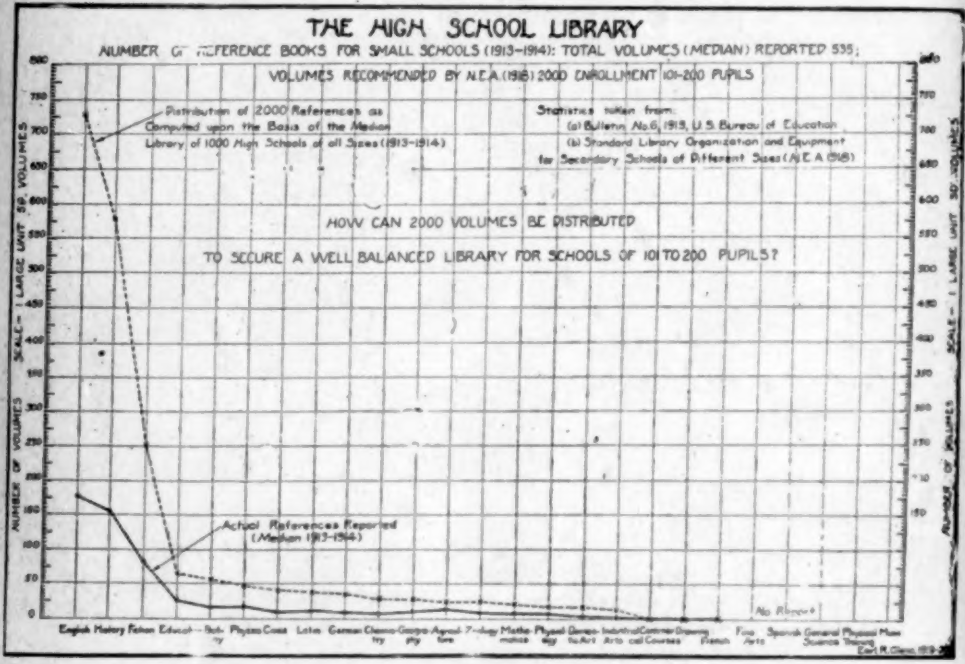


Fig. 6.

No report was submitted on the "ideal distribution."

Figure 6 shows a set of curves for schools (1913-14) enrolling 101-200 pupils. The median library reported contains 535 volumes. We do not assume that the computed distribution (dotted line) in these cases represents the proper distribution of references. As a matter of fact, the most satisfactory allotment will probably be quite different from what is shown here. Since it was not possible to secure sufficient data from the smaller schools, no medians have been used on the graphs for 1919-20.

Data from some of the best reports are shown for comparison. Figures 6 and 7 show some facts for schools enrolling 101 to 200 pupils. In Figure 7 the reader should note that the "ideal library" has a strikingly uniform distribution. A great many reports showed this uniformity.

Figure 8 shows the distribution of the median library of 658 volumes for schools (1913-14) with an enrollment of 201 to 300 pupils. If schools in this class succeed in building up the library to about 3,000 references in 5 years, in accord with the N. E. A. Library Committee Report, the broken line will show the approximate distribution, if the policies of the past continue

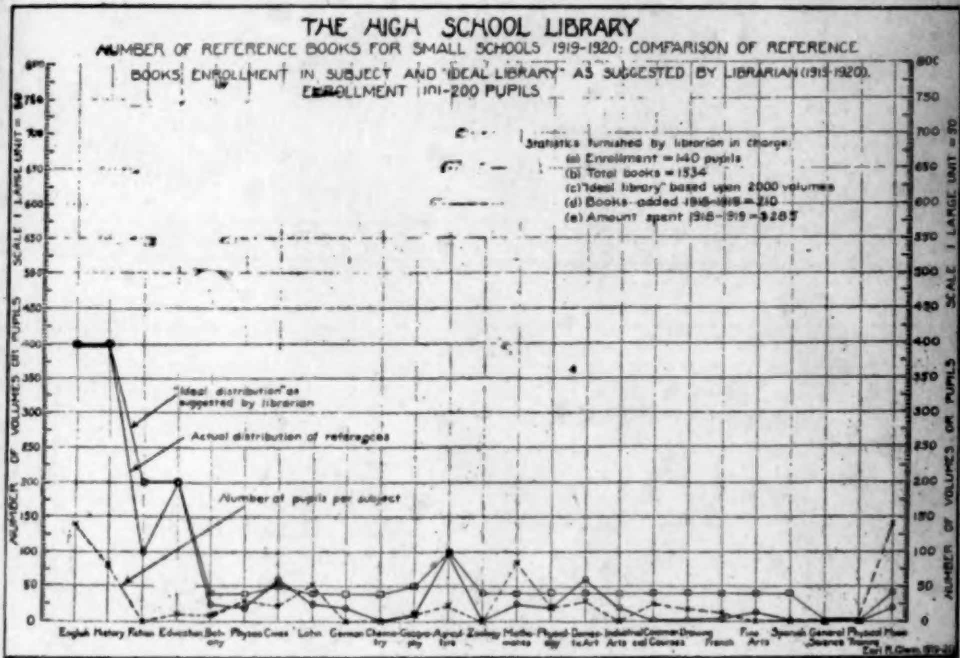


Fig. 7.

to operate in the matter of book selection. Figure 8 should be compared with Figure 9, but the reader should note that the scale units used are not the same.

The graph showing the actual distribution of references in Figure 9 gives some interesting information about book selection in this library.

Figure 10 deals with schools (1913-14) enrolling 301 to 500 pupils. The median library consists of 818 volumes. The facts shown in Figure 10 should be compared with those given

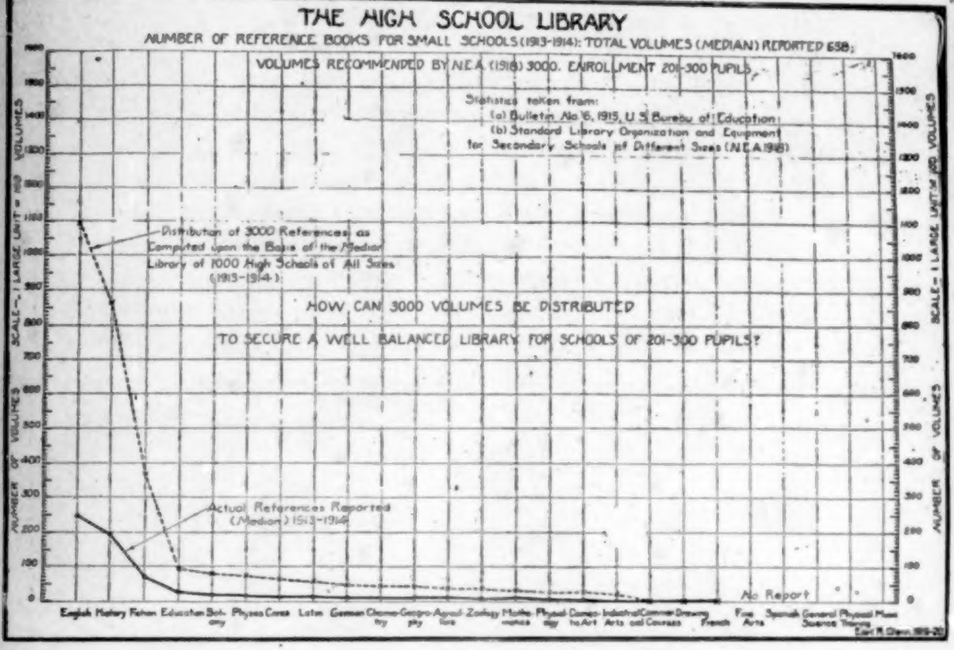

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR SMALL SCHOOLS (1913-1914): TOTAL VOLUMES (MEDIAN) REPORTED 658;
VOLUMES RECOMMENDED BY N.E.A. (1918) 3000. ENROLLMENT 201-300 PUPILS
Statistics taken from:
(a) Bulletin No. 6, 1915, U.S. Bureau of Education
(b) Standard Library Organization and Equipment for Secondary Schools of Different Sizes (N.E.A. 1918)
Distribution of 3000 References as Computed upon the Basis of the Median Library of 1000 High Schools of All Sizes (1913-1914)
HOW CAN 3000 VOLUMES BE DISTRIBUTED
TO SECURE A WELL BALANCED LIBRARY FOR SCHOOLS OF 201-300 PUPILS?
Actual References Reported (Median) 1913-1914
No Report
NUMBER OF VOLUMES SCALE—1 LARGE UNIT = 100 VOLUMES
Earl R. Glenn, 1919-20

FIG. 8.

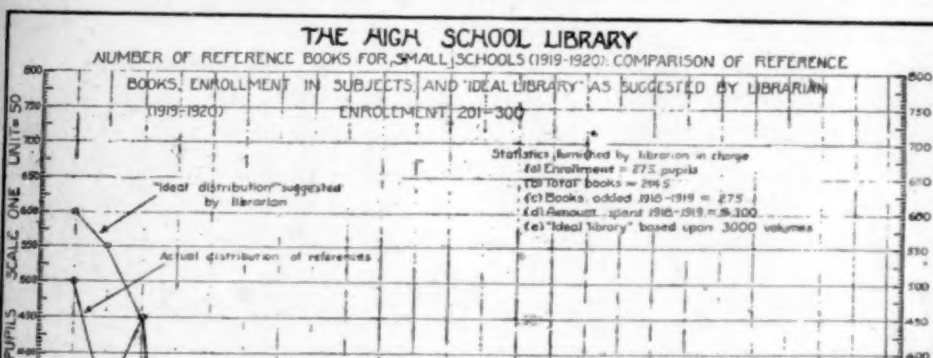

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR SMALL SCHOOLS (1919-1920): COMPARISON OF REFERENCE
BOOKS, ENROLLMENT IN SUBJECTS, AND "IDEAL LIBRARY" AS SUGGESTED BY LIBRARIAN
(1919-1920) ENROLLMENT 201-300
Statistics furnished by librarian in charge
(a) Enrollment = 275 pupils
(b) Total books = 2145
(c) Books added 1918-1919 = 275
(d) Amount spent 1918-1919 = $300
(e) "Ideal library" based upon 3000 volumes
"Ideal distribution" suggested by librarian
Actual distribution of references
Number of pupils per subject
NUMBER OF VOLUMES OR PUPILS SCALE ONE UNIT = 50
Earl R. Glenn, 1919-20

FIG. 9.

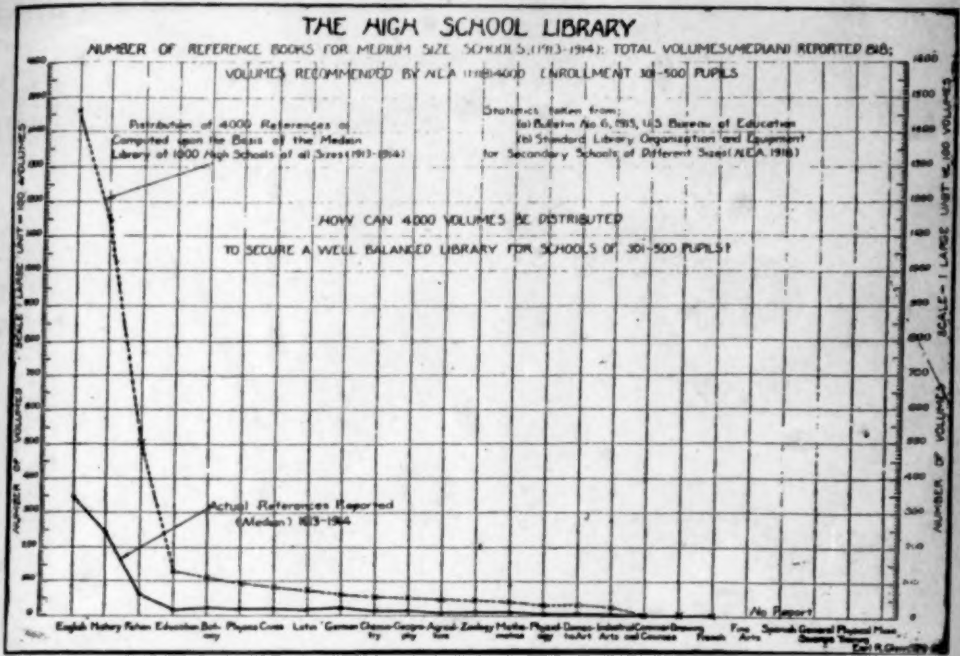

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR MEDIUM SIZE SCHOOLS (1913-1914): TOTAL VOLUMES (MEDIAN) REPORTED 818; VOLUMES RECOMMENDED BY N.E.A. (1918) 4000 ENROLLMENT 301-500 PUPILS
Distribution of 4000 References as Computed upon the Basis of the Median Library of 1000 High Schools of all Sizes (1913-1914)
Statistics taken from:
(a) Bulletin No 6, 1915, U.S. Bureau of Education
(b) Standard Library Organization and Equipment for Secondary Schools of Different Sizes (N.E.A. 1918)
HOW CAN 4000 VOLUMES BE DISTRIBUTED TO SECURE A WELL BALANCED LIBRARY FOR SCHOOLS OF 301-500 PUPILS?
Actual References Reported (Median) 1913-1914
No Report
NUMBER OF VOLUMES SCALE - 1 LARGE UNIT = 100 VOLUMES
English History Fiction Education Botany Physics Civics Latin German Chemistry Geography Agriculture Zoology Mathematics Physiology Domestic Art Industrial Arts Commercial Courses Drawing French Fine Arts Spanish General Science Physical Training Music

FIG. 10.

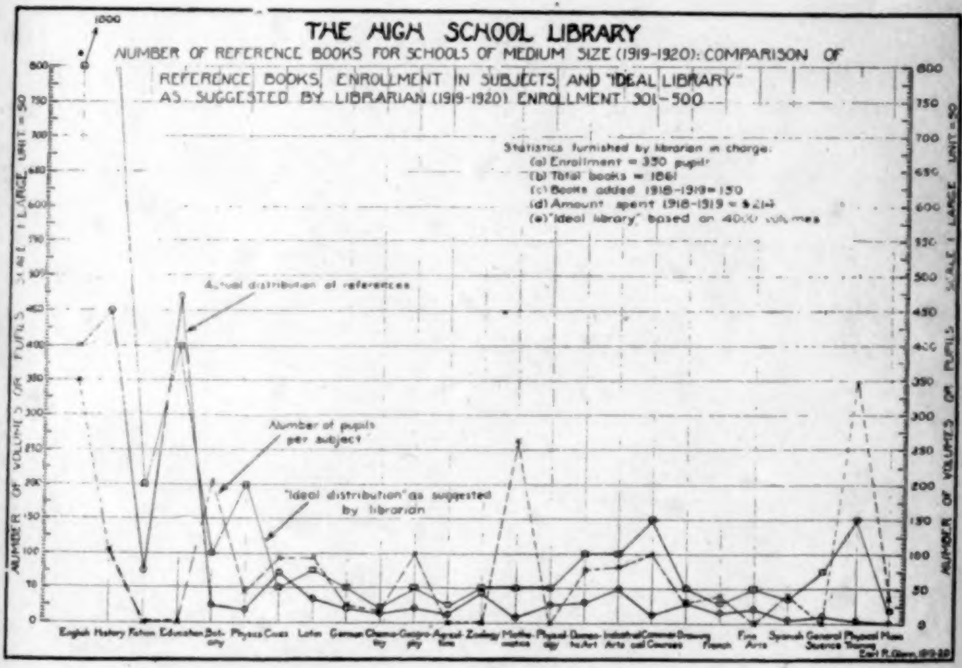

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR SCHOOLS OF MEDIUM SIZE (1919-1920): COMPARISON OF REFERENCE BOOKS, ENROLLMENT IN SUBJECTS, AND "IDEAL LIBRARY" AS SUGGESTED BY LIBRARIAN (1919-1920) ENROLLMENT 301-500
Statistics furnished by librarian in charge:
(a) Enrollment = 350 pupils
(b) Total books = 1861
(c) Books added 1918-1919 = 150
(d) Amount spent 1918-1919 = $214
(e) "Ideal library" based on 4000 volumes
Actual distribution of references
Number of pupils per subject
"Ideal distribution" as suggested by librarian
NUMBER OF VOLUMES OR PUPILS SCALE 1 LARGE UNIT = 50
English History Fiction Education Botany Physics Civics Latin German Chemistry Geography Agriculture Zoology Mathematics Physiology Domestic Art Industrial Arts Commercial Courses Drawing French Fine Arts Spanish General Science Physical Training Music

FIG. 11.

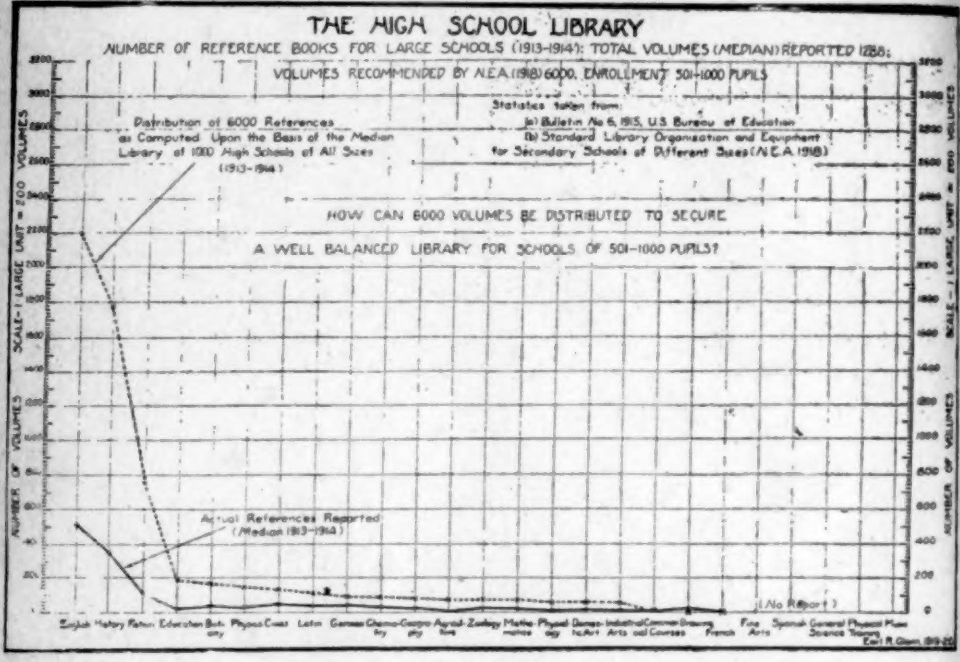

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR LARGE SCHOOLS (1913-1914): TOTAL VOLUMES (MEDIAN) REPORTED 1288;
VOLUMES RECOMMENDED BY N.E.A. (1918) 6000. ENROLLMENT 501-1000 PUPILS
Distribution of 6000 References as Computed Upon the Basis of the Median Library of 1000 High Schools of All Sizes (1913-1914)
Statistics taken from:
(a) Bulletin No 6, 1915, U.S. Bureau of Education
(b) Standard Library Organization and Equipment for Secondary Schools of Different Sizes (N.E.A. 1918)
HOW CAN 6000 VOLUMES BE DISTRIBUTED TO SECURE
A WELL BALANCED LIBRARY FOR SCHOOLS OF 501-1000 PUPILS?
Actual References Reported (Median 1913-1914)
(No Report)
NUMBER OF VOLUMES SCALE-1 LARGE UNIT = 200 VOLUMES

Fig. 12.

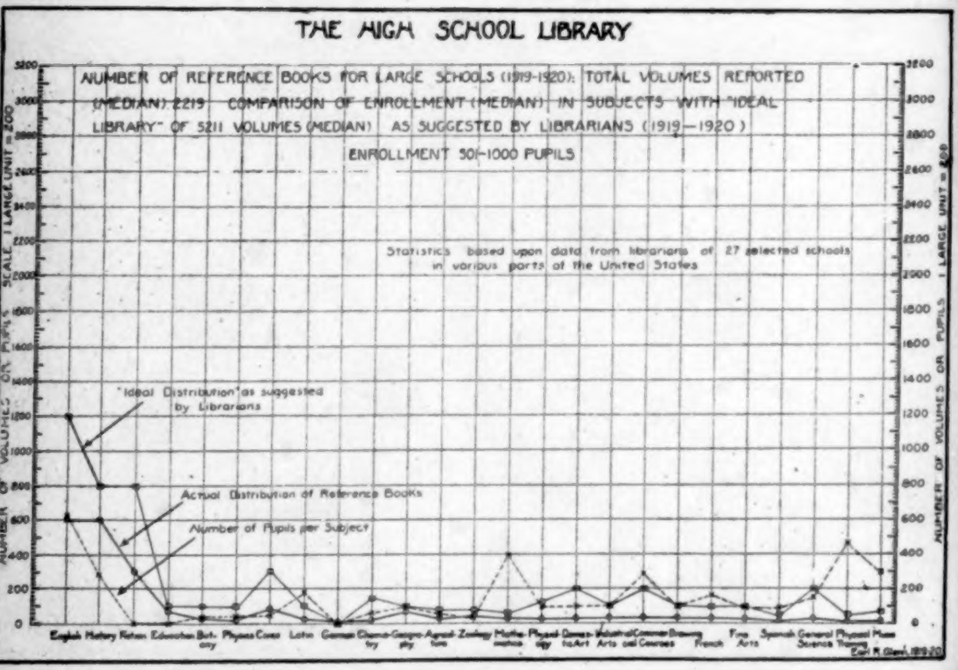

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR LARGE SCHOOLS (1919-1920): TOTAL VOLUMES REPORTED (MEDIAN) 2219. COMPARISON OF ENROLLMENT (MEDIAN) IN SUBJECTS WITH "IDEAL LIBRARY" OF 5211 VOLUMES (MEDIAN) AS SUGGESTED BY LIBRARIANS (1919-1920)
ENROLLMENT 501-1000 PUPILS
Statistics based upon data from librarians of 27 selected schools in various parts of the United States
"Ideal Distribution" as suggested by Librarians
Actual Distribution of Reference Books
Number of Pupils per Subject
NUMBER OF VOLUMES OR PUPILS SCALE, 1 LARGE UNIT = 200

Fig. 13.

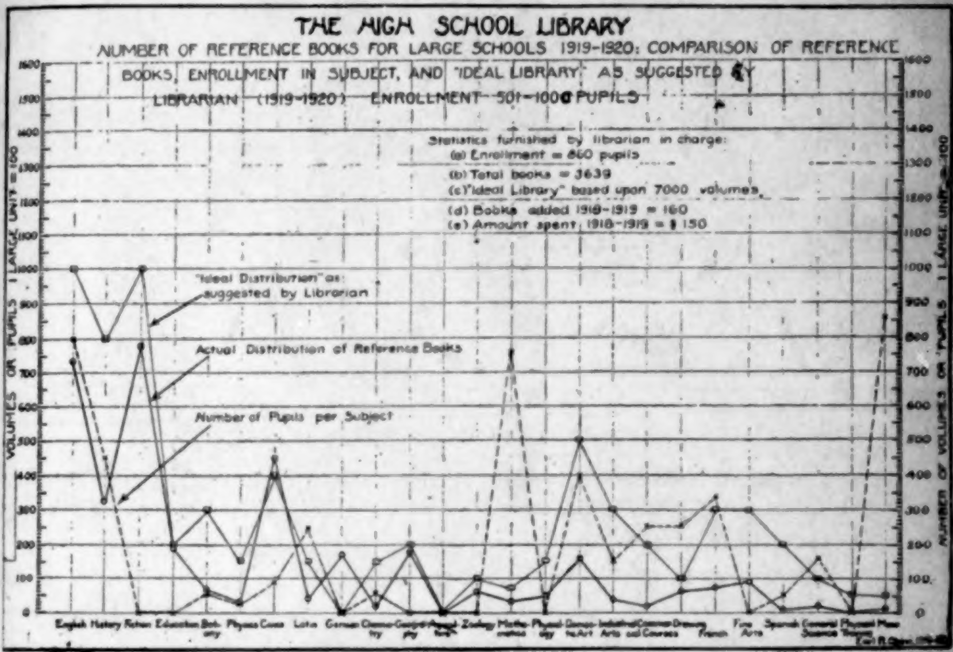

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR LARGE SCHOOLS 1919-1920: COMPARISON OF REFERENCE BOOKS, ENROLLMENT IN SUBJECT, AND "IDEAL LIBRARY" AS SUGGESTED BY LIBRARIAN (1919-1920) ENROLLMENT 501-1000 PUPILS
Statistics furnished by librarian in charge:
(a) Enrollment = 860 pupils
(b) Total books = 3639
(c) "Ideal Library" based upon 7000 volumes
(d) Books added 1918-1919 = 160
(e) Amount spent 1918-1919 = $150
"Ideal Distribution" as suggested by Librarian
Actual Distribution of Reference Books
Number of Pupils per Subject
VOLUMES OR PUPILS 1 LARGE UNIT = 100
NUMBER OF VOLUMES 1 LARGE UNIT = 100

Fig. 14.

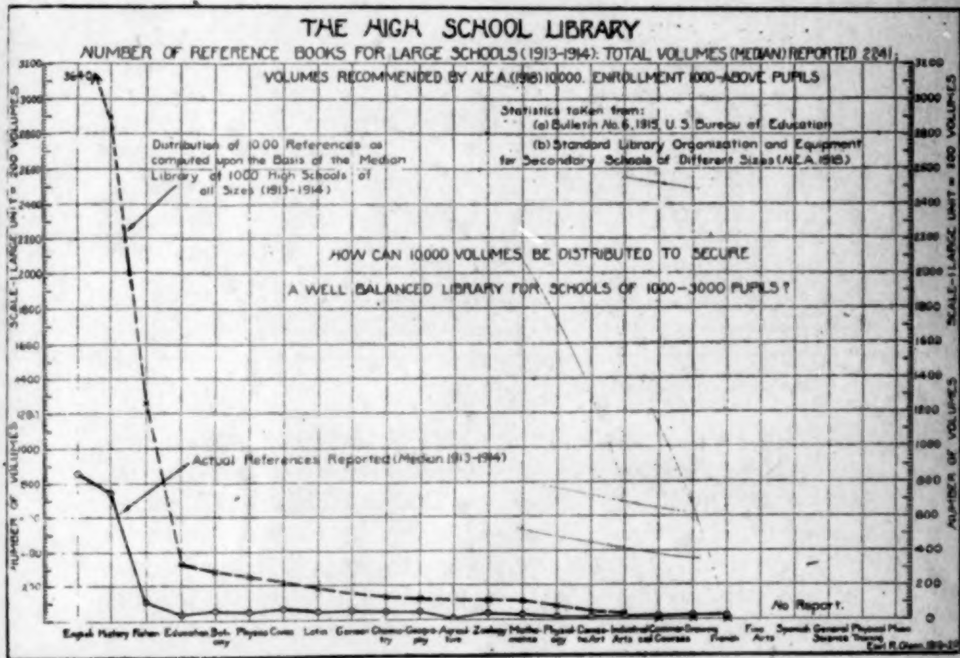

THE HIGH SCHOOL LIBRARY
NUMBER OF REFERENCE BOOKS FOR LARGE SCHOOLS (1913-1914): TOTAL VOLUMES (MEDIAN) REPORTED 2841; VOLUMES RECOMMENDED BY N.E.A. (1918) 10000. ENROLLMENT 1000-ABOVE PUPILS
Statistics taken from:
(a) Bulletin No. 6, 1915, U. S. Bureau of Education
(b) Standard Library Organization and Equipment for Secondary Schools of Different Sizes (N.E.A. 1918)
Distribution of 10000 References as computed upon the Basis of the Median Library of 1000 High Schools of all Sizes (1913-1914)
HOW CAN 10000 VOLUMES BE DISTRIBUTED TO SECURE A WELL BALANCED LIBRARY FOR SCHOOLS OF 1000-3000 PUPILS?
Actual References Reported (Median 1913-1914)
No Report.

Fig. 15.

in Figure 11. The reader will note that the scales of the two graphs are different.

The distribution of the median library of 1,288 volumes for schools (1913-14) having an enrollment of 501 to 1,000 pupils is shown in Figure 12. This graph should be compared with Figures 13 and 14. Since only 27 schools (1919-1920) are represented in Figure 13, the median has no great significance. It is important to suggest, however, that the reports used as a basis for this graph come from the best high school librarians in the country.

Those who are interested to see the distribution of a typical school in this class will find the data in Figure 14.

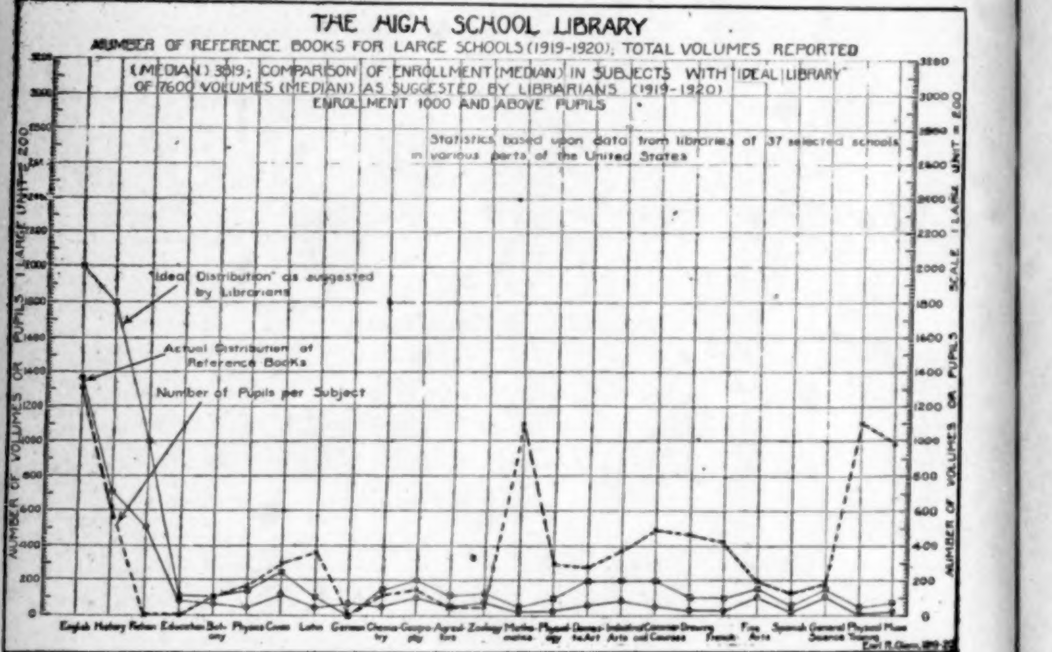


Fig. 16.

Figure 15 shows the distribution for the large high schools in 1913-14. The general distribution here is the same as for schools of medium and small enrollment. Figures 15 and 16 should be compared. Figure 16 gives the median values for thirty-seven of the best high schools libraries in the United States for the year 1919-1920. We have every reason to believe that this graph represents about the best practice in vogue in book selection in the large high schools. The "ideal distribution"

is made up from the estimates of the librarians in the large schools.

Figure 17 is added here to show the facts for a typical school of this class. The reader should compare the enrollment per subject with the references per subject.

Some have said that English and history require more references because more books are published in these subjects. In order to see what the adult world is doing in book-making, Figure 18 has been prepared. It was not possible to distribute the volumes by high school subjects, hence the reader should note the changes made along the horizontal axis of the graph.

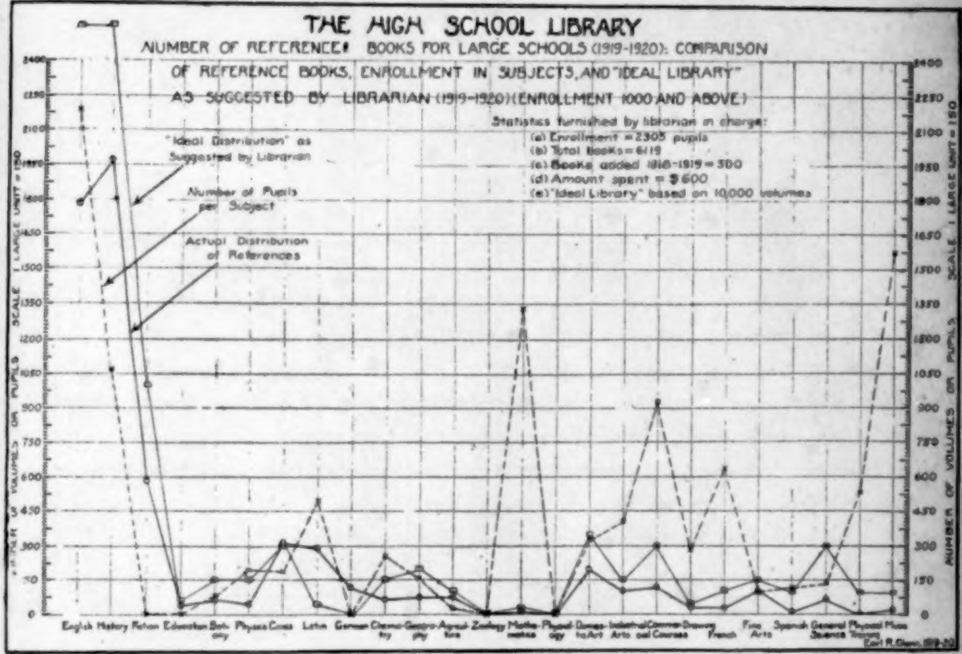


Fig. 17.

If we knew what percentage of the 1,105 books on history, etc., for example, published in 1912, are suitable for the high school library, then the problem of selecting a well-balanced library for any given school would be less complex than it now is.

V. General Summary.

1. Recent progress in the development of the high school library is indicated: (a) By the publication of a report on standardization of equipment and organization; (b) By state aid; (c) By cooperation of teachers, executives, and state high school

inspectors; (d) By the establishment of branch high school libraries.

2. This study shows graphically the distribution of high school reference books by subjects for 1,000 high schools for 1913-14 and 100 selected schools for 1918-19. By means of these graphs a school of any size may study its own practice in book selection and discover its errors of omission and commission.

3. Lantern slides of any or all of these graphs may be secured from the author. Duplicates of this graph paper which has been designed for this study may also be secured.

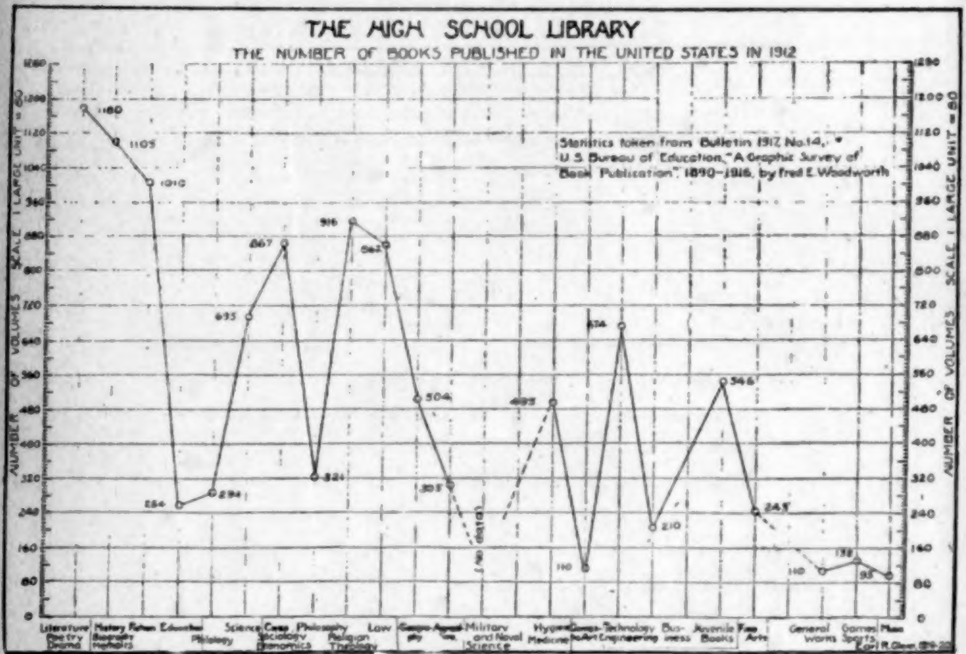


Fig. 18.

4. A well-selected high-school library is not the result of chance. The aggressive interest of some departments and the indifference of others result in an unbalanced collection.

5. The reports from approximately 1,000 high schools in fifteen North Central States in 1913-14 show that the great majority (over 70 per cent in the median library) of references in the library are listed under English and history. Neither the size of the school, the community, the type of school, the number of units of work offered, nor any other important factor seems to have influenced the distribution of references by subjects in any of these fifteen states.

6. Unless some comprehensive plan of book selection for all subjects can be put into operation, the five-year plan proposed by the Library Committee in the report mentioned above will not greatly benefit the subjects most in need of help.

7. The actual number of science references for the 1,100 different schools may be listed as follows:

Enrollment Pupils	Science References (Median) Reported for 1913-14	Report 1919-1920		Conservative Estimate of Number of References Required to Fulfill Five-Year Program of N. E. A. Committee (10 per cent of total for science)
		Actual No.	"Ideal" No.	
1-100	52	219	No Rept.	100
101-200	68	80	250	200
201-300	71	252	239	300
301-500	82	155	545	400
501-1,000	128	237	845	600
1,000 and above	219	426	990	1,000

8. Standard book-lists issued for high schools show great difference of opinion in the number of titles for certain subjects.

9 Detailed reports received from librarians of 100 selected schools for the year 1919-20 have been studied in comparison with the reports of 1,000 schools for 1913-14.

10. High schools in charge of librarians show a more equitable distribution of reference books. There is a great variation in opinion as to the proper distribution for a school of a given type. Some librarians use the policy of "to him that hath shall be given;" others assume that all departments should be adequately represented—even in the face of indifferent teachers.

11. In many instances there is a large unexplained difference between enrollment in the subject and references for the same subject in the best schools. The graphical methods used in this study show at a glance the condition of the school enrollment and library. By studying the enrollment per subject, and the present distribution of references a more nearly "ideal distribution" may be secured.

12. The number of books produced in the various fields of adult activity is given but we do not know what per cent of these are suitable for high school use.

13. It is probable that as the problem solving philosophy of teaching comes into more general use, greater demands will be made upon the library.

14. With a few exceptions the larger high schools furnished the most satisfactory data for this study.

VI. Some Constructive Suggestions.

In discussing plans for the improvement of the public high school library we need to keep in mind certain important facts relating to the country as a whole. A few statistics for 1917-18 Fig. 19 are given below:

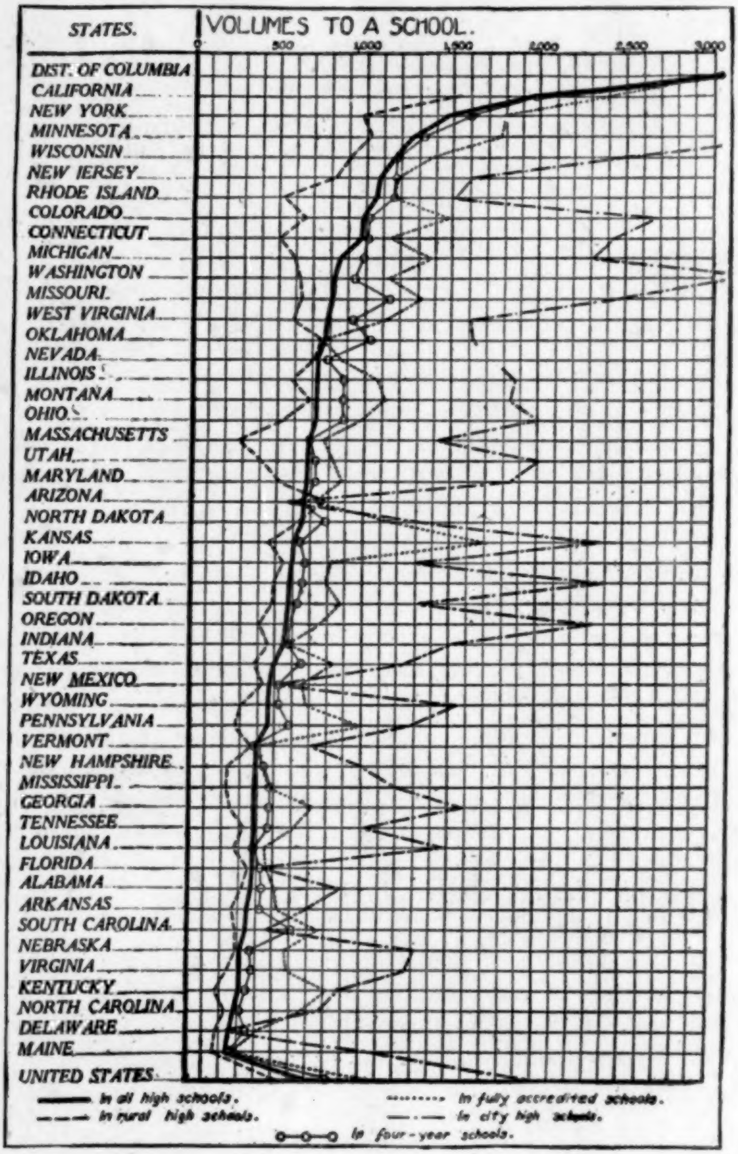


Fig. 19. The Average High School Library for Schools of Different Types.

(Graph by N. R. Bonner. Statistics of Public High Schools, 1917-18. Bull. 1920, No. 19.)

1. There are 10,638 four-year high schools.
2. These schools enroll 1,645,171 pupils, the enrollment having increased 710 per cent since 1890.
3. One-half of the high schools do not enroll over 50 pupils.
4. Three-fourths of the high schools do not enroll over 100 pupils.
5. Of 316 pupils who enter high school: (a) 229 reach the second year; (b) 166 reach the third year; (c) 142 reach the fourth year; (d) 131 graduate.
6. The average high school library for fully accredited (by state schools) high schools contains 1,047 volumes.
7. The average city high school (population 6,000 and above) library contains 1,980 volumes.
8. The average village high school (population 2,500 to 4,999) contains 1,000 volumes.
9. The average rural high school has a library of 524 volumes. On the basis of the facts presented in this study it would seem that scientific book selection for public high schools resolves itself into two major problems:

(A) We need an up-to-date book-list of about 1,000 volumes. This would serve as a guide for three fourths of the high schools of the nation. These subject lists should be made out with great care and thought by representative sub-committees appointed by the various organizations of teachers and checked by progressive teachers all over the country. These lists should be assembled and apportioned upon some reasonable basis of enrollment per subject and arranged in usable form by a committee of librarians and teachers. Standing committees on reference books by subjects should send in suggestions for revision each year. All of these details should be in charge of the U. S. Bureau of Education.

(B) A second list of 4,000 to 6,000 volumes is needed for schools of medium and large size. This list would be prepared in the manner suggested above. Apparently there is great need also for lists of suggestions to show departments how to use a library. Graphs for exhibiting library facts for the benefit of pupils and teachers should be included in these book-lists.

It is our opinion that in order to provide adequately for such subjects as industrial arts, foreign language, domestic arts, business, drawing, fine arts, and other subjects, it will be necessary to reduce the percentage of English and history books from the high value shown in this study to a much lower figure.

Much money can be saved especially for small schools and the cause of science teaching promoted if teachers and librarians will use the bulletins issued by state and national governments. Some idea of the amount of printing done by the United States Government can be obtained from the fact that about 12 1-2 tons of type metal are used and remelted daily in the printing bureau. Many trade catalogues can be obtained free of charge.

A NEW PARADISE.

By Harold B. Shinn,
Schurz High School, Chicago.

The dune region on the south shore of Lake Michigan has of late years become a famous rendezvous for biologist and geographer, and even should it fail to be saved from encroaching industrial enterprise, it will have served a good purpose—that of awakening a wide public interest in nature. It has been written about in many journals and has even furnished a livelihood to the lecturer, though we are not aware that it has yet produced a literature similar to that of the "Limberlost." But farther down the lake, away from the smoky pall of a great city and the shriek of nearby train, and unsullied by sardine tins and dirty paper napkins, lies a paradise as yet unknown and unexplored save by a very few. This spot should be visited at least once by every nature lover.

Ludington lies on the east shore of Lake michigan, easily accessible by railway from within the state or by steamboat direct from Chicago and from Milwaukee. The auto route connecting the shore cities of Michigan passes through it "on high." To the tourist who reads the older story there is pleasure in deciphering the glacial history, the advancings and retreatings of the ice sheet, the situations of large lakes and watercourses, and the piling up of moraines until they imitate very strikingly the Jurassic Alps. The locality abounds in small lakes and streams replete with fish, from trout to muskelunge, with bass and pickerel always numerous. Game birds, too, there are, and the shore line migration route makes possible bird studies hardly to be duplicated in the central states.

Society in summer hugs the town, boating, motoring, professional baseball, golf, and a chautauqua amusing a few thousand tourists and resorters. But six miles north begins a wonderful wilderness, a hundred square miles in extent. Here is our "Paradise." Beginning at the west, one finds the xerophytes of wide beaches and high dunes. Eastward for many miles are alternating hills, with dead lakes and lagoons between them, and broad moors of sphagnum, cranberry and huckleberry. A part of the government reservation, near the Great Point Sauble light, is a large tract of primitive timber to be penetrated only with a compass at hand, and here still lurk the deer and bear. Cranberry, huckleberry of several varieties, and the wintergreen are yearly harvested, each in its season, by Indians and venturesome whites.

The forester revels in the variety of the woods. Like the glacial soil, a heterogeneous mass of many materials, so the trees seem thrown together by a lavish hand; beech, ash, birches too, oaks, maples, cherry, hemlocks, spruces, tamarack, pines and cedars challenge him. The ecologist is at a loss where to begin his work. Indian pipe, ginseng, sundew, orchids, pitcher plant, and lichens are without number. Ant lions pit the dune sides; spiders of many habits burrow or build their homes and snares; the gulls and snowy geese and a lone bald eagle sail between the crystal sky and the great emerald lake while from hill to hill sounds the flute of the cardinal.

The southern boundary of this paradise is Hamlin Lake and its heading stream, Sauble River. These waters furnish pleasure enough and excitement enough for the most exacting throughout the year. It matters little whether the student enters the domain at one season or another. In spring the trout are taking the fly, the partridge are drumming, and the arbutus bedecks the hillside, throwing its delicate scent to the winds, while in shady woods trilliums and Canada violets, phlox and Dutchmen's breeches, carpet the ground. In midsummer the lake is "in bloom" with plankton, insect life is at its height, while chewink and warbling vireo lure you farther into the thickets. In fall the squirrel and chipmunk are busy with nut and seed, the hunter is bagging his stock to be frozen for use until spring comes again, and in the foliage nature is breaking down her greens through the series of catalyses to reds, yellows, and browns. Snowshoe and ski, in winter, carry you over the trail with camera or gun or trap for fox, muskrat, or skunk, or maybe you fish for "muskies" through the ice.

Words are inadequate to describe this rendezvous so easily accessible to nature lovers of the central states, and SCHOOL SCIENCE AND MATHEMATICS has asked one of the permanent residents, formerly a city dweller, to describe certain phases of the life as she knows it.

WINTER AT HAMLIN LAKE.

Dec. 1, 1920.

"Every day I find something interesting, and wish I could spend all my time wandering through the woods and marshes, to see how the plants, as well as the little animals, have provided for the winter; and still hardly a day passes that I don't receive a letter saying, 'How do you spend your time? I should think you would die of lonesomeness out there in the woods!' My dear

friends, what is lonesomeness? How can one be lonesome with all the beautiful and interesting things God has given us to enjoy in this wonderfully beautiful country?

"The weather so far has been very mild and most of the leaves are still on the trees, and I still find the little wild aster in bloom, where it has been sheltered a bit, and now and then a bluebell and many strawberry plants are blossoming. I have never seen the wintergreen plant so loaded with berries; it is a pretty sight, the patches of green and red wherever you go. The trees are also loaded with the winter fruit, the cedar trees so loaded with seed and fruit, the hemlock and spruce with many little cones. A few weeks ago I took a party of friends to the bluffs to gather bitter-sweet and by the time we reached there, they all had their baskets filled with interesting things, among them the wonderful trailing arbutus in bloom, for the weather was so nice it just could not wait until spring.

"Thanksgiving morning seemed like spring, for as I went out to feed the chickens, a flock of robins greeted me with their 'cheerily—cheer-up' and the little chickadees tried to tell me how happy and contented they are here. We have the little song sparrow and the creepers, nut hatch and junco in great flocks. The little chipmunks and red squirrels have been very busy this fall, for where they had to live mostly on acorns for the last few winters, they now have had all the beechnuts they want to store away; in one hollow stump where I knew a chipmunk lived, I found at least three quarts of beechnuts and acorns.

"We have a great many partridge this year, for the weather was very favorable during hatching time, for baby partridge cannot stand wet weather and when we have a cold wet spring, many of the little ones die. This is ideal weather for them, too, for they have lots to eat, as they like the wintergreen berries and beechnuts and they are well protected from the hunter as well as the owl on account of the heavy foliage on the trees and shrubbery. Every time I go for a walk through the woods I see them, in pairs mostly, but very often in flocks of six to eight, and usually when I have my basket instead of the gun.

"Hamlin Lake has always been a place where the wild duck come in great flocks, and from the time the season for hunting opens, we have duck of many species and we spend early mornings and late afternoons in hunting.

"Last winter at this time we had the suet baskets and feeding boxes filled for the little birds, for we had lots of snow and

very cold weather and the little friends had hard work finding food until they came to us; but this year it is so mild and there is so much for them to eat I have decided not to feed them until the snow covers the ground, for fear it will make them lazy and they might suffer later on when it gets really cold. We have one hundred and twenty bird houses on our premises and thirty suet baskets. We also have fifteen feeding boxes and in cold weather I bake bread for the birds and put it in the feeding boxes. I mix corn meal, oat meal, bran and a little wheat flour, with enough water to make a stiff dough, and add a little molasses and soda, which makes very good food for them, and if you could see them at the feeding boxes you would not have to ask, 'Do they like it?'

God's Country.

"While you're living in the city, with its fashion and its strife,
I think, dear friends, you are missing part of life—
For here in God's own country, we're as happy as can be,
Don't have to copy fashions, and every day we see
Something new and interesting. I assure you there is charm
In what God gave us to care for, to enjoy and keep from harm.
There is no thought of envy, no need to sit and think,
'Which gown would look the best on me, shall it be blue, or pink?'
For our friends are not ashamed of us, no matter what we wear,
And when they see us coming, we are sure to find them there,
Waiting patiently to greet us. They never ask the recipes
Of the things we set before them, we just know that they are pleased
By the way they twit and twitter, as they fly from tree to tree.
Eating suet and the meal cakes, they are happy as can be."

—["Mary A. Nurnberg."

FILM ILLUSTRATING PLANE GEOMETRY.

Mr. Charles H. Sampson of the Massachusetts Department of Education is now at work preparing a film on the subject "Definitions of Plane Geometry."

This is something unique in educational matters. A portion of this film was recently shown at a teachers' convention in Boston and created a great deal of favorable comment. The completed film will soon be shown to the public, after which it will be ready for distribution.

This, undoubtedly, is the first time that anything of this kind has been attempted in this direction. Mathematics teachers should get in touch with Mr. Sampson concerning the matter.

COLLEGE EDUCATION PAYS.

By Jos. F. Wright.
University of Illinois, Urbana.

In the past few years, particularly since the close of the war, there has been an unprecedented growth in the number of college students. Particularly since the war has the increase been at an accelerated rate.

A reliable statitician recently stated that the number of students has increased from 187,000 in 1914 to 294,000 in 1920. At the same ratio of increase, another decade would give us over 500,000 students in colleges and universities.

A frequently asked question is, "*Why* this increase?"

The ever increasing demand for trained men and women perhaps offers the surest answer. There was a time, and not so long ago, when the value of a college or university education was considered debatable—when men argued as to whether the college-bred boy was more likely to make a failure in business than the uneducated boy. Today the advantage of such an education to the young man starting on a business career—or a farm career, for that matter—is generally admitted by the great business leaders of the country.

From a reliable source we are told that four-fifths of the corporations questioned on the matter showed a preference in favor of college men. The same report stated that from the combined records of a hundred business houses, ninety per cent of the college men entering their employ advanced to responsible positions and large salaries, while only twenty-five per cent of non-college men entering their employ made corresponding advance.

One hundred business firms cited the following qualifications as possessed by the average college man in far greater degree than the non-college man: mental poise, adaptability, imagination, ambition, refinement, comprehension, ability to analyze, self-confidence, initiative, resourcefulness, judgment, habit of concentration, system, originality, and others.

Such are the odds given the university trained man, and such are the handicaps placed upon the non-university man. Our boys and girls are coming to realize these facts more than ever before. Is it any wonder then, that our colleges and universities are filled to overflowing?

This increasing demand on our higher institutions of learning

means a great problem in providing trained men and women, and money to meet the expense.

Educational institutions of advanced standing have proved during the last decade their direct economic advantages to the people. The most thoughtful citizens of the country have come to realize in a practically tangible way that discoveries which technical education has brought about are individually worth much more to industry and civilization than are the combined expenditures which might be made for higher education in the next century.

The people need to have this point brought home to them as it affects themselves. Using Illinois as an example, we find that the University of Illinois at present faces difficulties which, unless remedied, will render further contributions to industry and the activities of its people impossible.

Only six weeks or so ago the University announced that it had developed a new variety of wheat which has, on a five year average, outyielded its predecessor six bushels to the acre. The yield of corn, Illinois' greatest crop, has been turned from a gradual decline to a decided upward trend, and Illinois land is now bought and sold upon the basis of soil survey conducted by the University. The Engineering Experiment Station of the University has carried on comprehensive tests and has advanced accurate information on engineering problems which has been worth untold sums to the engineering activities of Illinois' industries. Similar steps in the advancement of the state's business and volume of trade have been proffered to Illinois' business men as a result of research work which has been done by the College of Commerce. The same general trend is true of all the colleges and experiment stations of Illinois' great institution of learning. If the University did no teaching work it would justify the appropriations made to it on the basis of research; yet in addition to this great work it is training Illinois' young men and women in the economic and social practices that go to make up progress.

And yet this great addition to wealth stands in danger of being cut off because of the financial reasons. Unless considerable relief is granted by the legislature now in session the opening of the new biennium will see a decided reduction of the work of the University. The income of the mill tax for the present University year is $2,500,000, an increase of less than 11 per cent since 1912; yet since that time the purchasing power of the

dollar has fallen fifty per cent; the student enrollment has increased to 10,000, an increase of 100 per cent; it is impossible to get teachers because of inadequate salaries; many lines of research are being suspended; extension work, which carries information direct to the people, has been diminished; classes are too large to teach properly, equipment is inadequate, and laboratories and class rooms are insufficient in number.

The people of Illinois are not so mentally constituted as to see this condition of affairs prevail. The University of Illinois, although making a seemingly large request—$5,250,000 per year for the next two years—is not asking as much as other similar institutions are getting; it is asking merely a conservative estimate. It merely seeks to provide sufficient equipment to make its work efficient; to increase its staff in proportion as enrollment has increased; to provide a margin of income for a steady increase in teaching, research and administration; to bring the working equipment up to date; and to add necessary buildings.

It may be the country will presently awake to the fact that it can afford to spend for education a fraction of the gold wasted in waging war; that our capitalists, financial kings and captains of industry, and our legislators will adopt a more generous attitude toward higher education and provide such facilities by state, national, and private appropriation that no young man or woman will be denied an education. Our country needs to be awakened to the financial necessities of our teachers, our schools, our colleges and universities.

DAILY OIL DEFICIT OF THREE-EIGHTHS MILLION BARRELS.

In September of last year, as in August, the daily output of the United States oil wells was slightly over one and one-fourth million barrels, but the daily consumption rose to one and five-eighths million barrels. This daily deficit of three-eighths of a million barrels was met by imports from Mexico.

In meeting the world's need for oil the United States has played a large part. In the last 60 years our contribution to the world's output of oil has been never less than 44 per cent (the figure during the brief period when Russia led), and earlier reached even 99 per cent, while of the total eight billion barrels, so far consumed by the world, five billions have come from the wells of the United States.

There is urgent need of pioneering the world for oil to meet the needs of this generation, but there is no warrant for regarding this advance into new fields as beginning a contest whose aim is world conquest. The present need of the United States for oil from abroad can be met only by world-wide exploration, development, and operation by American companies backed up by our government; and we should expect other nations that are embarrassed by a similar or even greater discrepancy between consumption and production to adopt the same policy.

RECENT PROGRESS IN THE USE OF OZONE IN VENTILATION.

By F. O. Anderegg,

Purdue University, Lafayette, Ind.

The name ozone is associated with freshness in the air such as experienced after thunderstorms, and in the open country at almost all times. Great interest has been taken in the observation of "ozone days" in the past and a large amount of data has been accumulated, mostly of little value. With these associations the name possesses good advertising value and advantage has been taken of this to exploit the use of ozone to an extent comparable almost with gold mining or oil well prospects. The great number of extravagant claims, which have been made, have tended to bring this activated form of oxygen into considerable disrepute with scientists and others who like to be careful as to the truth of the statements they accept. The reaction has been so great that a good many people have come to think that the term "ozone" and all it signifies is merely a snare and delusion. Just because bad oil stock has been sold is not a good reason for believing that all oil stock is worthless; nor is it right to allow oneself to be completely prejudiced by extravagant claims of certain unscrupulous persons. Let us, first of all, consider the actual facts of the case.

Ozone *does* seem to have a stimulating effect if taken at the correct concentration. Thus right after a thunderstorm when the air is exhilaratingly fresh, ozone is present at a concentration of about one part in ten million. This is sufficient to act on a sensitive photographic plate. Such a concentration is not at all harmful but is actually stimulating. But this stimulation is not one with harmful after-effects, since it consists of the addition to the blood of a more active modification of oxygen, which is then used in oxidizing the fuel in the body, making available more energy for muscular work.

Other stimulants like alcohol have injurious side actions which often cause a great deal of harm. But even here the claim is made and supported by considerable evidence that alcohol in small concentrations is practically harmless and may even be possibly beneficial. The ill effects of highly concentrated alcohol are too well-known to need more than mere mention. In a similar manner ozone of a concentration of more than one part in a million becomes harmful. It begins to attack the mucous membrane with very disagreeable results. Headaches are produced which are apt to be very disagreeable. It does

not take very much ozone to make more than one part in a million of air, so that the mistake that has been made by most exploiters of ozone generators is to use apparatus of too high capacity. With the production of too much ozone disagreeable results have followed, so that this substance has been brought into disrepute.

For office ventilation there are produced by many concerns in this country and abroad cabinet ozonizers which produce a lot of ozone for a very small power consumption. Since a large part of the price of the apparatus depends upon the size, the tendency has been, partly through greed and partly through ignorance, to make ozonizers too big. I have known of a great many cases where these cabinets have been installed in banks and offices and after a while they had to be discarded because of producing too great a concentration. To be successful the amount of ozone should be so low that the ordinary person should not notice its presence on entering the room where it is used. Most of the cabinet forms of ozonizers have had perhaps ten times too great a capacity.

There are certain places where it would be very desirable to have better air. The crowded office and schoolroom, the well-attended movie theater and church, or the basements of the large department stores, all have trouble in securing proper ventilation. There seem to be exhaled from the human body certain substances which tend to make the air feel "close" and after they have been breathed a little while a person becomes drowsy and feels uncomfortable. To provide fresh air the atmosphere in a crowded room has to be renewed sometimes as many as eight times an hour. In the cold weather this means that a lot of coal is required to warm up all of this air which does not remain behind very long before it is discarded. If some means could be provided for removing the deleterious substances from this air, allowing it to be recirculated there would be a great saving of coal.

The question then arises as to whether ozone will accomplish this desirable result. About this question there has been waged quite a little controversy pro and con. Emphatic statements have been made on both sides, so that it is somewhat difficult to decide just what the truth of the matter is and a careful survey of the literature does not settle the question either way, since there are not sufficient results of decisive experiments to allow one to decide. Until the question has been cleared up

by high class experimental work, which will analyze the problem into its different factors, we will have to fall back upon certain positive results which have been actually obtained in practice

In St. Louis the schoolrooms where colored children or the children of the "great unwashed" portion of the population gather are rather hard to ventilate. A number of the teachers in such schools were complaining of ill health and great discomfort from the inadequate ventilation. The children, too, would become drowsy and the school work did not go forward as it should. When some of the teachers threatened to resign, the problem was put up to Mr. Hallett, the chief engineer of the school board. He recommended the use of ozone and had it installed in two of the worst schools. After that complaints ceased and a questionnaire sent to the teachers found them enthusiastic about the new system. Not only were they relieved from the almost nauseating odors, but also the children were taking an interest in their work they had not shown previously. The experiment was so successful that the use of ozone has been extended to many other school buildings in that city and now when a new building is put up an ozone system is always included.

Economically the big advantage of the system is that the air can be recirculated so that a large part of the heat is saved. The writer visited a school in the city of St. Louis where air was recirculated with the aid of ozone. The odor of ozone was barely perceptible, so that it was not disagreeable. The children were not at all drowsy, as they so often are in the middle of the afternoon, but were very wide awake. The teachers, on being questioned, were quite enthusiastic about the ventilation, and one dear old frail lady said that she had not lost a day since the introduction of ozone, whereas, before, she had lost a great deal of time.

Successful installations have also been made in the offices of the Brown Shoe Co. and in the system for ventilating the great basement of the Grand Leader department store. Usually in the basement of a large department store the ventilation is very bad, but none of that is to be noticed in this place. The air that enters from the outside is partly ozonized, passes over one set of heating coils, through a humidifier, and then over another set of heating coils and out into the room. The odor of ozone can barely be detected by a sensitive nose. The people employed there are unaware that ozone is being used nor have they any complaint to make about the ventilation.

That there is a great field for improvement in the ventilation of most of our crowded buildings almost no one will deny, but that ozone would give relief is strongly doubted by a great many people. The reason for the doubt has been that, while a little ozone is a good thing, a great deal is too much of a good thing. In most installations the trouble has been that not little enough

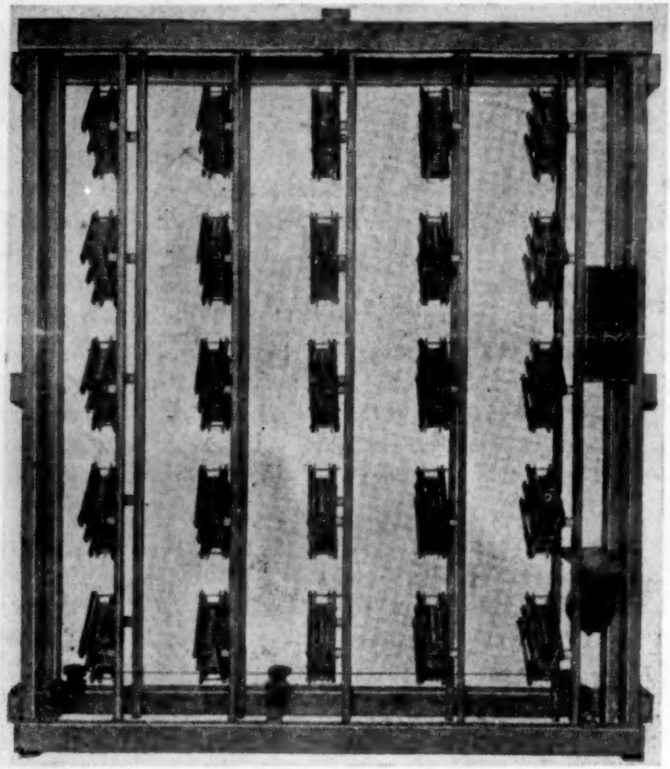


FIGURE 1. FRAME ASSEMBLY AS USED IN FRONT OF TEMPERING COILS.

ozone has been used. Like perfumery, the best effect is secured by the use of almost vanishingly small quantities. If the ozone treated air is allowed to come in contact with water, as in a humidifier, most of the ozone is decomposed. During the decomposition the opportunity to oxidize any organic matter present would be very great, so that a very high percentage of bacteria and bad odors would be removed and destroyed.

Ozone, moreover, has a tendency to cling to the clothes and the skin which are the sources of many of the bad odors. The writer has noticed the smell of ozone clinging to his fingers and

clothes for a couple of hours after working with the substance. Such an accumulation of ozone near the origin of the deleterious substances would be especially effective in preventing them from getting out into the air. Before these ideas are accepted generally, however, very carefully controlled experimental work must be done. It is believed by many who have gone into the matter carefully and without prejudice that ozone can be successfully used to solve a large number of the problems of ventilation, provided constant care is taken to allow for its peculiar properties and the resulting limitations placed on its use.

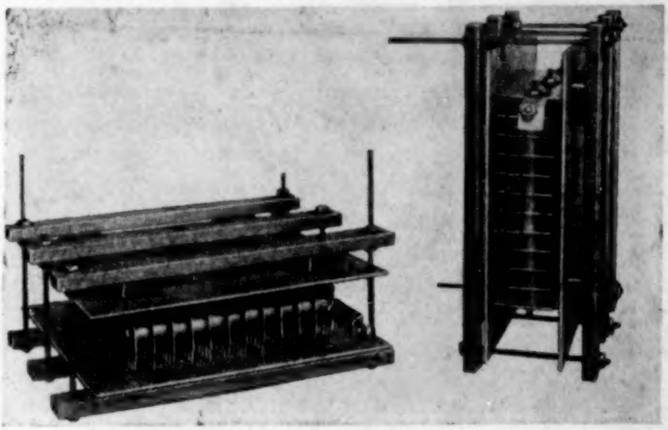


FIGURE 2. SINGLE UNIT USED IN FRAME.

The cost of ozone production for ventilation is almost negligible. An ozonator taking 20 watts will furnish sufficient ozone to take care of a schoolroom containing forty children. That is about half the power required by an ordinary incandescent light. Where the air for a whole building passes through a preliminary heating coil, then through a humidifier and finally through another heating coil, it is convenient to install a bank of ozonators, with a unit for approximately each room, in the most convenient part of the air duct, before the air reaches the water spray. Where multiple units (Fig. 1) are used, the transformer loss is distributed among several so that fifteen watts per unit is not an uncommon figure. A convenient form of ozonator (Fig. 2) uses aluminum points close to a micanite dielectric, back of which is a thin sheet of lead foil. This form has the advantage of being easily cleaned. Dust is always electrostatically precipitated and in the old fashioned tubular ozonizers is very difficult to remove. The dust on the walls

diminishes the efficiency of the apparatus considerably. A transformer is required to step the ordinary A. C. lighting circuit of 110 volts up to about 5,000 volts. The whole apparatus can be protected by screens so that there will be no danger from the high voltage.

Those of you who have to teach in crowded rooms where the ventilation is poor, who frequently experience the discomfort and even nausea produced by a concentration of odors from the human body, or who have to pay the coal bills where tremendous volumes of fresh air must be heated to secure adequate ventilation, might find it well worth-while to look into the proper use of sufficiently dilute ozone. The advantages are: a reasonable cost, almost negligible power requirement, a safe apparatus requiring very little attention, an ability to recirculate the air, saving sometimes half of the coal bill and not only the removal of the deleterious odors produced in crowded places, but also an actually stimulating atmosphere. Incidentally, some interesting statistics have been secured on the freedom of school children, where suitable ozone systems have been installed, from colds, influenza, and similar diseases. Would it not be pleasant to breathe air that is continually as fresh as that after a thunderstorm?

ALUMINUM, AUTOMOBILES, AND ARKANSAS.

In these days, when the number of automobiles parked by laborers around apartment houses in course of construction is greater than the number that may be owned by the occupants of the finished apartments and when street-car companies see their revenues decreasing because so many people have their own conveyances, the demand for aluminum greatly exceeds that of a few years ago, when automobiles were less common. The bodies, engines, and other parts of some automobiles are made of aluminum to reduce their weight, and this use and the other uses of aluminum in the form of castings and drawn and pressed ware has necessitated the enlargement of several aluminum-making plants and the construction of new ones during the last few years. The increasing use of aluminum foil to replace the more expensive tin foil has also necessitated an increase in producing capacity.

In view of these facts it is somewhat surprising that the value of the primary aluminum produced in the United States in 1919, $35,558,000, was about 6 per cent less than that in 1918, according to the United States Geological Survey, Department of the Interior. This decrease, however, was due chiefly to the accumulation of large stocks in 1918. With a favorable market the output in 1920 may be greater than ever.

The automobile and aluminum industries are closely connected with Arkansas, because that State furnishes nine-tenths of the bauxite mined in the United States, and bauxite is the clay-like mineral from which most aluminum is derived. The total quantity of bauxite produced in the United States in 1919 was 376,000 tons, of which 333,000 tons, valued at $1,855,000, was mined in Arkansas.—[U. S. Geo. Survey.

A BILL TO FIX THE METRIC SYSTEM OF WEIGHTS AND MEASURES AS THE SINGLE STANDARD FOR WEIGHTS AND MEASURES.[1]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after ten years from the date of passage and approval of this Act the weights and measures of the meter-liter-gram or metric system shall be the single standard of weights and measures in the United States of America for the uses set out herein.

Sec. 2. That the fundamental standards of the meter-liter-gram or metric system are the meter and the kilogram. The meter is the length at the temperature of 0 degrees centigrade of the international prototype meter bar of platinum-iridium defined and adopted by the General Conference of Weights and Measures held at Paris in 1889, which bar is now deposited in the International Bureau of Weights and Measures at Sevres, France. The kilogram is the mass of the international prototype kilogram weight of platinum-iridium which was similarly adopted and deposited.

Sec. 3. That the national prototypes of the fundamental standards of the metric system shall be the copies of these standards known as meter numbered twenty-seven and kilogram numbered twenty, allotted to the United States by the General Conference of Weights and Measures held at Paris in 1889. These are now deposited in the vault of the Bureau of Standards of the Department of Commerce and are those which are now used and employed in deriving the values of all weights and measures used in the United States. These national representations are hereby adopted as the primary standards of weights and measures for the United States of America, and from these all other weights and measures shall be derived and ascertained.

Sec. 4. That from and after ten years from the date of passage and approval of this Act no person shall do or offer or attempt to do any of the following acts, by weights or measures, in or according to any other system than the metric system of weights and measures, namely:

(1) Sell any goods, wares, or merchandise except for export, as provided in section 12;

(2) Charge or collect for the carriage or transportation of any goods, wares, or merchandise; or

(3) Charge or collect from or pay to or reimburse any other person for work or labor which has been or is to be performed or done, except that when in accordance with the provisions of section 12 weights or measures other than those of the meter-liter-gram or metric system are used or employed in the arts, manufacture, or industry the wages of employees engaged in producing commodities in such weights or measures and paid by weight or measure of commodity produced may be computed and paid in terms of such weights or measures.

Sec. 5. That from and after four years from the date of passage and approval of this Act no person shall manufacture or make for himself for use, or purchase for use, or convert to use, in any of the transactions detailed in section 4, any weight or measure or weighing or measuring device designed, constructed, marked, or graduated to determine, indicate, or deliver weights or measures in any other system than the metric system of weights and measures.

[1]In the House of Representatives on December 29, 1920, Mr. Britten introduced the following bill, which was referred to the Committee on Coinage, Weights and Measures and ordered to be printed.

SEC. 6. That from and after ten years from the date of passage and approval of this Act no person shall use or attempt to use in any of the transactions detailed in section 4 any weight or measure or weighing or measuring device designed, constructed, marked, or graduated in any other system than the metric system of weights and measures.

SEC. 7. That from and after two years from the date of passage and approval of this Act no person shall manufacture or pack, offer for sale, or sell any goods, wares, or merchandise in package form which are required by law to be marked in terms of weight or measure unless they be marked in or according to weights or measures of the metric system except the goods, wares, or merchandise on hand, and except for export as provided in section 12. Prior to ten years from the date of passage and approval of this Act there may also be marked upon such packages the equivalent of the metric weight or measure in terms of weights or measures now in customary use. From and after ten years from the date of passage and approval of this Act the marking in terms of weights and measures now in customary use is hereby prohibited, except for export as provided in section 12.

SEC. 8. That not later than ten years from the date of passage and approval of this Act all postage, excises, duties, and customs charged or collected by weights or measures by the Government of the United States shall be charged or collected in or according to the metric system of weights and measures.

SEC. 9. That rules and regulations for the enforcement of this Act not inconsistent with the provisions hereof shall be made and promulgated by the Secretary of Commerce.

SEC. 10. That all equivalents between the units of the meter-liter-gram or metric system and the system now in customary use shall be calculated from the fundamental relations, one meter equals 39.37 inches, and one kilogram equals 2.204622 pounds avoirdupois. Tables based upon these relations, showing the equivalents between the weights and measures of the metric system and those now in customary use, shall be prepared and promulgated by the Secretary of Commerce. The Secretary of Commerce shall also take such steps as he may deem expedient for giving publicity to the dates of transition specified herein and for facilitating the transition to the meter-liter-gram or metric system.

SEC. 11. That all Acts or parts of Acts inconsistent herewith are hereby repealed but only in so far as they are inconsistent herewith; otherwise they shall remain and continue in full force and effect. Whenever in any Act, or rules and regulations, or tariff or schedule made, ratified, approved, or revised by the Government of the United States of America weights or measures of the system now in customary use are employed or referred to, and to comply with the provisions of this Act weights and measures of the metric system should be employed, then such references in such Act, rules and regulations, tariff, or schedule, shall be understood and construed as references to equivalent weights or measures of the metric system ascertained in accordance with the fundamental relation set out in section 10 hereof.

SEC. 12. That nothing in this Act shall be understood or construed as applying to—

(1) Any contract made before the date at which the provisions of this Act take effect;

(2) The construction or use in the arts, manufacture, or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed, or graduated in any desired system;

(3) Goods, wares, or merchandise intended for sale in any foreing

country, but if such goods, wares or merchandise are eventually sold for domestic use or consumption then this clause shall not exempt them from the application of any of the provisions of this Act.

Sec. 13. That nothing herein shall be understood or construed as prohibiting the enactment or enforcement of weights and measures laws or ordinances by the various States or cities, and the various States or cities shall have the same powers as though this Act were not in force and effect: *Provided, however,* That no standard weights or measures, shall be established for the uses set out herein which conflict in any way with the standards established herein, and such standards which may already have been established shall be null and void for the uses set out herein.

Sec. 14. That the word "person" as used in this Act shall be construed to import both the plural and singular, as the case demands, and shall include corporations, companies, societies, and associations. When construing and enforcing the provisions of this Act, the act, omission, or failure of any officer, agent, or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission, or failure of such corporation, company, society, or association as well as that of the person.

A PARENT'S REQUEST.

Is the following request complimentary or otherwise to Mr. Brown and Miss Jones?

"My Dear Mr. Smith:

"Kindly allow my son to drop Mr. Brown and Miss Jones as teachers, allowing him to take others in their place, owing to the fact that he works every night and must have more sleep.

(Signed.) "A. FINKLEBERG."

A 1A GIRL'S THEME ON TRANSPORTATION.

We are justified in printing this as it can very properly be assigned to our Geography Department. We do not advise, however, that teachers should use this information in their classes:

"Transportation."

"The natives of America used to transport things in a very difficult way, and a long way to travel, it took them a long time. They did not had the opportunities as we have now. They had barrels made wood and they put the things inside, and covered it. Then they put four pieces of wood around the barrel, in square form; at the end of one side and at the end of the other were tied a cord made of wild plants that are flexible. It was pulled by eight men if it was heavy. Things that were not so heavy they carried own their backs.

"When the new settlers came they domesticated buffalos. They used buffallos for transportation of heavy things. The buffalos used to pull wagonns that were very simply made. Small articles wed carried in their own backs. It lasted for many years before they started to use horses for transportation. In the year 1753 civilization was increasing, and transportation was caried by horses instead of carring on their own backs. Years after they used canoes for transportation.

"Now all the transportations are very easily carried on, from one state to another and from one cantry to another. We are able to transport many things that are nesesary for us, for example we export many things and import for example mahogany wood, Gold, silver, coffee, sugar cane and many other things that come from Mexico."

GEOLOGICAL SURVEY NEEDS A PROGRAM.

One of the outstanding features of the Forty-first Annual Report of the Director of the United States Geological Survey, just made public, is the statement that though, during the 40 years of its existence, the Geological Survey's policy has been to contribute material for a national plan to gain scientific knowledge of the Nation's mineral resources, yet the greatest need of the Geological Survey today is a plan for itself—a program. The recognized function of a scientific bureau is to collect and arrange facts upon which the Nation may base its plans for future development, but the Geological Survey now finds itself unable to plan adequately its own development. It lacks that assurance of continued appropriations that would encourage or warrant long-term investigations, a few of which are absolutely essential to any forward looking program of scientific research. The increasing gap between the Government scale of professional salaries and the scale prevailing in commercial employment causes a continual change in personnel that makes the administration of scientific work almost hopeless. The responsible official, in arranging to have the work done that is most needed, actually has his choice of projects determined for him by the personnel available. For each scientist of fully tested ability available the choice has to be made between several pieces of work, all of which deserve immediate attention. Even less satisfactory is the situation in which an urgent call for a geologic field examination has to be met by assigning to it an untried worker.

The net result is that the Geological Survey is not fully occupying the field which is recognized as peculiarly its own. It could, however, occupy that field. With slightly increased appropriations, and especially with the declaration of intent by Congress to regard the scientific bureau as having successfully passed its probationary period, greater stability might be expected and some progress might be made in the adoption of a program fitted to the country's needs.

ENGINEERING DATA NEEDED.

The new law providing for the leasing of Uncle Sam's coal, oil, phosphate and other mineral lands imposes on the United States Geological Survey of the Department of the Interior the determination of the mineral character of the lands. The new water power law likewise imposes on the Geological Survey the determination of power possibilities.

One of the items in the working program of the Geological Survey whose value in this connection was foreseen but whose adoption has not been possible is the mapping of geologic structural features favorable to oil accumulation in the Western States prior to the enactment of oil-leasing legislation. The need for such mapping was realized, for it would be helpful alike to the oil operator and to the Government official administering the new law, but as set forth in the annual report of the Director of the Geological Survey, just made public, neither men nor money have been available to do more than touch the outer edges of this project. Similar preparation for the water-power law was obviously desirable but could be made only in part.

The examination of storage sites made by the Geological Survey in 1888-1891 was pioneer work that marked a beginning in the larger utilization of the water resources of the West, and it is unfortunate that this special investigation was discontinued, for now authoritative information of this kind would be invaluable in planning the storage of flood waters for power and irrigation in the West and for power development, improvement of navigation, and flood protection in the East. The Nation can well afford to invest in engineering data for future use.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS' ANNUAL MEETING.

Secretary's Report.

The association held its annual business meeting at the Englewood High School, November 27, 1920, with President Foberg presiding.

The minutes of the meeting of November 29, 1919, were approved as read.

It was voted to accept the treasurer's report as of November 25, showing receipts of $2,898.92 and expenditures of $2,245.53, with a balance on hand of $652.39. The final report for the year will be submitted to the Executive Committee at its first meeting in 1921.

The treasurer asked for instructions regarding the fees of those who had access to the official organ of the association, School Science and Mathematics, and who therefore did not wish their membership fees to include the subscription price of the journal. Reference to the constitution revealed no authority for a reduction of the membership fee on such grounds. Several members discussed the advisability of making constitutional provision for such a class of membership. The point was made that the association cannot afford to do anything which will embarrass the journal for it is an important factor in maintaining and increasing the association's influence in its wide territory. On the other hand it may be advisable to establish session memberships which would admit holders to the meetings of any one year. This might be an effective means of establishing an interest in the work of the association on the part of many teachers of science and mathematics of the city in which the meetings are being held. It would affect the present policy of admitting the public to our meetings without charge or fee. The entire question was referred by vote to the Executive Committee with instructions to report at the next annual meeting.

The report of the Committee on Resolutions was accepted and adopted:

Resolved, That the Central Association of Science and Mathematics Teachers in convention assembled at its twentieth meeting expresses its appreciation and hearty thanks to Dr. W. D. Richardson, Professor B. R. Buckingham, Mr. D. F. Campbell, and Professor F. R. Moulton for their inspiring addresses of the general program; to Principal J. E. Armstrong, Mr. W. E. Tower and teachers of the Englewood High School, the members of the Englewood Women's Club in charge of the lunchroom, and the musical organizations and student ushers and checkroom helpers, for their very hospitable provision for the comfort of the members of the association and their guests; and be it further

Resolved, That we hereby express our appreciation to President Foberg and other officers who have labored to make the meeting a success by helpful general programs and those of the different sections.

An especial mention is due to Mr. W. E. Davis for surpassing all previous records in obtaining advertisements to meet the increasing costs of publishing the book of programs.

Be it further resolved, That we, recognizing the condition of apathy of the general public toward civic betterment, do urge upon our membership and all teachers the great necessity of their continued unselfish efforts at making the next generation a better one and of upholding those ideals that will make a greater America.

Herbert R. Smith,
W. F. Roecker.

Mr. C. M. Turton, chairman of the Nominating Committee, presented the following ticket:

President, Walter W. Hart, University of Wisconsin, Madison, Wisconsin; Vice-President, Harry O. Gillet, University of Chicago, Chicago, Illinois; Secretary, Glen W. Warner, Englewood High School, Chicago, Illinois; Corresponding Secretary, Edith I. Atkin, State Normal University, Normal, Illinois; Assistant Treasurer, W. F. Roecker, Technical High School for Boys, Milwaukee, Wisconsin.

The treasurer, Lewis L. Hall, was elected in 1919 for a term of two years.

The secretary was instructed by vote to cast the ballot of the association for all the nominees on the ticket.

Mr. Jerome Isenbarger read the report of the Committee on Necrology. It was accepted by rising vote.

The other members of the committee, Mr. Alfred Davis, Soldan High School, St. Louis, and Mr. F. W. Runge, Township High School, Evanston, Illinois, cooperated with your chairman in securing data concerning deaths which have occurred among our membership during the past year.

The committee has learned of four deaths. The persons who have been taken are Alberta Drew, Dr. Henry S. Carhart, Edward Morgan, and W. Thornton Smallwood.

Alberta Drew was a teacher of earth science in the Joliet, Illinois, Township High School. She had been a member of the geography section of the association for several years and had served that section on the Executive Committee.

Dr. Henry S. Carhart had been a member of the association for many years. He read the first major paper delivered before the association. He was a graduate of Wesleyan University, a valedictorian of the class of 1869. He received the degree L. L. D. from his alma mater and the same degree from Northwestern University when Professor of Physics, 1872-1886, and the degree Sc. D. from the University of Michigan in 1912. He did research work at Harvard, Berlin, Zurich, and the Bureau of Standards at Washington.

Dr. Carhart was recognized as a world authority on standard cells. He made many contributions to scientific journals. He held the following offices: President of Board of Judges of Electricity at the Columbian Exposition, 1893; President of the Electro-chemical Society; Vice-President of the Physics Section of the American Association for the Advancement of Science; President of the Wesleyan Guild of Ann Arbor, Michigan; represented the University of Michigan at the Darwin Centennial at Cambridge University in 1919. He was the author of Electrical Measurements, University Physics (2 vol.), College Physics, and with Mr. H. N. Clute, Elements of Physics, High School Physics, First Principles of Physics, Physics with Applications, and Practical Physics. He was preeminently a Christian scholar.

Edward Morgan was a graduate of the University of Indiana with the degrees A. B. and A. M. At the time of his death he was assistant principal of the Nicholas Senn High School, Chicago. He had held this position since the establishing of the school, eight years ago. He was an untiring and conscientious worker. He won the respect of his pupils and fellow teachers for his strict discipline and exact and scholarly methods of instruction.

W. Thornton Smallwood was a member of the faculty of the Harrison Technical High School, Chicago. His chosen field was zoology. He was a graduate of the University of Syracuse. He was a man of strong personality which made itself felt not only in the classroom but with the boys on the athletic field. He was admired and respected by pupils and his fitness and ability were recognized by his fellow teachers.

JEROME ISENBARGER, Chairman.

Mr. W. E. Davis, chairman of the Advertising Committee, made an informal report which showed the following comparisons:

	Old Ads	Lost	New	Total	Income
1919	48	2	8	56	$548
1920	50	6	17	67	788

The report was accepted with applause.

Mr. Davis recommended that the association secure one person more or less permanently for this work. He ought to be one who spends his summers in Chicago and who is in a school with a commercial department. The association ought to allow him a commission of five or ten per cent in recognition of his services. It is highly advisable to adopt effective means of increasing our income from this source and to insure against decreases. The work should be started as early as the first of April. Special stationery for the chairman of this committee would probably prove a good investment.

The report of the Membership Committee was received and accepted.

Number of letters mailed	5,900
Additional stationery	$ 8.00
Multigraphing	18.00
Revision of mailing list	12.00
Postage	62.12
Telephone	1.15
Addressing of envelopes	29.75
Folding and mailing	17.75
Total expense	148.77

John K. Skinner, Chairman.

Mr. Foberg suggested that new chairmen of committees, especially advertising and membership, consult with former chairmen with reference to the means which they have found most effective in carrying on the work.

Dr. Elliott R. Downing moved that the Reorganization Committee be discharged as a general committee as its work has been accomplished as far as it can be at this time. The Section Committees are to be encouraged to continue the work if they so desire. The motion was seconded and carried.

Dr. Downing asked that each section be represented, so far as it wishes to be, at a meeting to be held in the Christmas holidays to consider the advisability of organizing a National Council of Science Teachers.

A letter from the Journal of Home Economics was read, announcing an increase in the subscription price to $2.50 with a ten per cent discount to publishers and agents. The treasurer was empowered by vote to pay the higher rate for the subscriptions for which the association is responsible. The increase is to be effective January 1, 1921.

The question of the selection of a meeting place for the 1921 convention was discussed but the decision was left in the hands of the Executive Committee. The secretary read letters and telegrams of invitation from Cincinnati and St. Louis.

Harry O. Gillet, Secretary.

Treasurer's Report.

At the annual meeting the treasurer submitted the following report for the fiscal year November 28, 1919, to November 26, 1920.

Treasurer's Report, November 26, 1920.

Receipts.

Regular memberships	$1,716.50
Irregular memberships	28.20
From advertising	617.30
Balance and credits	536.92
Total	$2,898.92

Expenditures.

Subscriptions, SCHOOL SCIENCE AND MATHEMATICS	$1,092.43
Printing	574.28
Subscriptions to Journal of Home Economics	37.80
General	541.02
Balance cash on hand	653.39
Total	$2,898.92

In any interpretations of these figures it must be remembered that the balance carried over after the audit of November 28, 1919, consists in part of receipts from advertising and memberships paid before the annual meeting. The former treasurer, Mr. J. H. McClellan, followed the practice of beginning his serial members with the annual meeting regardless of the number of people who had paid memberships for that year previous to the meeting.

The present treasurer has begun his serial numbers for the year with the first one paying for the year, 1921, so the number on the receipt indicates the whole number who have paid dues to date for the current year.

The number who paid during and following the annual meeting in November, 1919, for the year, 1920, was 700. As has been indicated there was an advance registration of 231 making a total membership, including eight honorary members, of 931.

Since, according to a constitutional requirement, we carry on our books as members all those who are not more than one year delinquent (barring resignation) the number who paid for 1919 but not for 1920 was 130. Adding this to the 931 who paid, we have a membership in terms of the constitution of 1,061.

It is difficult to estimate as yet what effect the raising of the dues from $2.50 to $3.00 will have on the membership for the reason that about 550 got in under the time limit and got the $2.50 rate while the remainder paid $3.00. It is worth noting, however, that the receipts for memberships, regular and irregular, in 1919 were $1,826.15, while in 1920, they were $1,744.70. We shall know more about it at the end of the year of 1921.

While at the time of this report the printing bill for 1920 programs was not in, everything points to the conclusion that it will be higher than the item shown, while other items are not less.

Since October 1, we have been paying $2.00 for SCHOOL SCIENCE AND MATHEMATICS.

The treasurer is not pessimistic but believes it would be folly not to note that in common with the business world, it is not a time for undue expansion, but rather a time for taking stock of our resources and necessary expenses and seeing to it that the latter do not exceed the former.

There are yet many teachers in secondary schools in our lines who are still outside the organization, and our greatest problem is to convert these potential members into "kinetic" members.

LEWIS L. HALL, Treasurer.

Minutes of the Biology Section.

The Biology Section of the C. A. S. and M. T. was called to order at two o'clock on Friday, November 26, by the Chairman, Miss Grace Baird, of Bowen High School, Chicago.

Dr. John M. Coulter of the University of Chicago gave the first address. He reported on the botanical work of the National Research Council, beginning with the year 1916. There were three major phases to this work, namely

1. Increased production and conservation of *food*,
2. Added and new uses as well as the conservation of *timber*, and
3. Increased production of *raw materials;* and the finding of substitutes for necessary materials previously brought from foreign countries.

The work of this council had not alone the result hoped for, that of solving problems industrial and economic, but also the general recognition of science as a national asset and the cooperation of scientific and practical men as well as the recognition of the fact that science's greatest service is to supply the public need.

Dr. W. H. Osgood, who was to report on the zoological work of the National Research Council, was not present because of illness.

Dr. Henry C. Cowles of the University of Chicago, whose subject was "Imported Plants in the United States," pointed out that all of our major crop plants and most of our small fruits and vegetables had originated in places far from the localities of present distribution. He suggested the advisability of carrying on the work of improving some of our native plants in order to add American varieties to our list of important plants.

Mr. R. B. Miller, the Illinois State Forester, gave an illustrated talk on Forestry in the Mississippi Valley. The State Forestry boards of the Central states are all putting forth every effort to preserve natural woodlands and to reforest such land as is deemed advisable.

Mr. Guy Guernsey of the Aquarium Club, in his talk on Illinois Fish, made an appeal it is well to heed. The streams of Illinois are polluted so that fish cannot thrive. Something should be done to clean up the streams and keep them clean. He suggested that a hatchery should be established so that in the future our streams and ponds might be stocked. It is welcome news to many that a new aquarium is to be built in Grant Park, Chicago. The architecture of the aquarium is to be in keeping with the Field Museum.

The officers elected for the ensuing year are as follows: Chairman, Mr. Clarence Bonnell, Harrisburg, Ill.; Vice Chairman, Mr. A. M. Wheeler, Gary, Ind.; Secretary, Miss Louise Sawyer, Grinnell, Iowa.

The Biology Section did not meet for conference on Saturday, November 27. The following excursions were conducted to points of interest about the city: one under the leadership of Mr. Holzman to the Garfield Park greenhouses and one to the Lincoln Park Conservatories lead by Miss Ella Krache. Mr. H. Schinn conducted a party through Swift and Company's plant and the International Stock Show at the Stockyards.

Elsa K. Harjes,
Secretary pro tem.

Minutes of the Chemistry Section.

Friday Afternoon, November 26, 1920.

The meeting was called to order in Room 316, Englewood High School, by the President B. J. Rivett of Northwestern High School, Detroit, Mich. The number present was about fifty.

The following committees were appointed:

Resolutions: H. R. Smith, Lake View High School, Chicago; R. W.

Osborn, Francis Parker High School, Chicago; C. D. McLouth, Muskegon, Mich.

Nominating: Col. H. D. Abells, Morgan Park Academy, Morgan Park, Ill.; Frank B. Wade, Shortridge High School, Indianapolis, Ind.; Ralph S. Powers, Department of Education, University of Ark.

Prof. W. D. Harkins of the University of Chicago, who two years ago gave such an interesting and instructive address on "The Structure of the Atoms, the Evolution of the Elements, and the Periodic System," which address was later published in full in SCHOOL SCIENCE AND MATHEMATICS, addressed the section again this year on the subject, "The Structure and Building of Atoms." A great deal of work has been done by Professor Harkins during the last two years, many new points were brought out and others cleared up. A large number of visitors from the Physics Section came to hear this very instructive address.

W. D. Richardson, the chief chemist of Swift and Company, Chicago, Ill., gave a short talk on "Hydrogenation." He gave in an interesting manner the history of hydrogenation of oils, bringing out the need of a catalyst, and that the first patents were taken out in England in 1902-03 by soap manufacturers after it had been discovered that unsaturated hydrocarbon gases could be saturated by passing them with hydrogen over finely divided nickel. They found that oleic acid could be hydrogenated by a similar method and converted into a hard mass of stearic acid. The action goes through to conclusion without side reactions and works even more easily with neutral oils. Keiser, who had worked on hydrogenation in England, took out patents in the U. S. Later he conceived the idea that if edible oils were used the solid mass resulting could be used for edible purposes. He also stated that there was no reason why we should use solid fats, except custom. Hydrogenation orignated in pure science and was then put to practical purposes.

Dr. Albert L. Smith of Englewood High School, Chicago, performed an interesting experiment showing supersaturation and the heat produced by subsequent crystallization when a small crystal is introduced. In a 1,000 cc, flask he had placed enough "hypo" to fill it about two-thirds full. After introducing about 1-8 to 1-10 as much water as crystals, the flask with contents was placed on the steam bath till all was liquified. This now can be used day after day, and year after year. If when a small crystal of "hypo" is dropped in the supersaturated solution, all the liquid does not crystallize, the excess should be poured off. George Sype of Austin High School, Chicago, offered the suggestion that a few drops of water was sufficient. Dr. Smith also showed that similar results may be secured with sodium acetate.

In the absence of David M. Davidson of McKinley High School, Chicago, Ill., Frederick B. Emery of the Harrison Technical High School, Chicago, Ill., exhibited before the section some useful pieces of apparatus. Instead of the hard glass test tube or the ordinary copper retort which are more or less unsatisfactory for generating oxygen, Mr. Harrison finds that a gas-pipe equipped with a retort fitting gives satisfactory results and is inexpensive. By means of McIntosh bench and clamp, and silver illuminator, he uses an ordinary compound microscope to project crystallization. Among the many other useful pieces of apparatus mentioned were: Automatic Blower, water-cooled for blast lamp and glass blowers; the Tungar Rectifier, equipped with ten ampere fuse instead of three ampere. One and two burner ordinary gas plates are used to advantage in heating large amounts of water. Electric plates, electric flask heaters and electric stirring devices are very useful. The aluminum pressure cooker can be used for the impregnation of wood

under pressure, for as much as thirty pounds per square inch can be developed. Interval timers and cut-offs, electric centrifuges for rapid precipitation and the use of valence blocks were mentioned. Mr. Harrison mentioned that he had used to advantage silica ware in place of platinum and that he deliberately plunged a red hot dish of silica ware into ice water and found that it did not crack till it had been submitted to this process fifteen times. Dentist drills were found useful in grinding numbers on glass bottles.

Mr. Brown, who was exhibiting for the W. M. Welch Company, demonstrated a piece of apparatus which, by means of a magnetic field and a pan of mercury in which small steel balls to represent electrons were placed, illustrated the structure of the atom.

SATURDAY MORNING, NOVEMBER 27, 1920.

The Committee on Nominations reported as follows: Chairman, George Sype, Austin High School, Chicago, Illinois; Vice-Chairman, G. A. Bowden, Univ. School, Cincinnati; Secretary, J. Aaron Smith, H. S. Danville, Ill.

It was moved and probably seconded that the secretary cast the ballot of the section, for these candidates. Carried.

The Committee on Resolutions presented the following report:

Resolved, That the thanks of the Chemistry Section be extended to the faculty and officers of the Englewood High School for their courteous hospitality which has made this meeting so pleasant. Further be it

Resolved, That these thanks be extended in large measure to the retiring officers of the section for the worth while program which we have enjoyed, and further be it

Resolved, That we continue the past efforts of the section to make the subject of chemistry a worth while, vital part of the education of every pupil in the high school.

Resolved, That the Chemistry Section of this association, through its secretary, convey to Prof. Alexander Smith of Columbia University, its solicitation for his recovery of health and his continued helpful influence on the teaching of chemistry.

Resolved, That chemistry should be taught the youth in high school for the value of the subject to the individual rather than for the advancement of science; therefore, in the selection of matter and mode of presentation, regard should be had for tastes and requirements of sex and the various circumstances of life rather than for the scholastic requirements of higher institutions.

Prof. B. W. Peet of Michigan Normal College, Ypsilanti, Michigan, delivered an address on "The Theory of Chemical Reaction," which you will find in full in the December issue of SCHOOL SCIENCE AND MATHEMATICS.

Mr. C. M. Wirick of Crane Technical High School, Chicago, gave a talk on "Chemistry Adapted to Social Needs." He recommended that chemistry be taught as a laboratory course, the book being used for reference. Things closest at hand, such as atmosphere, water, food, plants, soil, breakfast foods, etc., should be studied. Mr. Wirick suggested a unification of the sciences with two years general science, at the end of which students who desired could more easily be put through straight physics and chemistry. Science then would have the continuity of mathematics and languages and the accompanying value. Mr. Wirick thinks that by adapting chemistry to social needs that it would raise the intelligence of the whole community ten to fifteen per cent.

S. R. Powers, of the Department of Education in the University of Arkansas, formerly of University High School, Minneapolis, Minn., read a paper on "A Study of Some Chemistry Tests." J.K.STOUFFER, Sec'y.

The report of the committee on "Reorganization of Chemistry Courses" was presented by H. R. Smith of Lake View High School, Chicago. Much credit must be given to this committee for its valuable work. The report follows:

"In presenting its final report the committee wishes to review in a general way the main points that have been developed during the course of its work.

I. Aims.

It has formulated five aims in the logical order of their importance as a guide in the teaching of chemistry:

1. The necessity of awakening the minds of our pupils to the possibilities of achievement.
2. The understanding and use of the scientific method of procedure.
3. Acquisition of knowledge which serves as a basis of skills.
4. Comprehension of life and social relationships.
5. Inculcation of moral law.

These aims have been agreed to by all members of the section that have cared to reply to the questionnaire sent out, and were formally adopted at the section meeting on November, 1919.

The committee strongly urges the members of the section, now that we have agreed on these aims, to keep them in mind and consciously endeavor to realize these objectives.

II. Fundamental Subject Matter.

The committee next recognized the fact that one year of time is too short to teach thoroughly all the topics that pertain to the chemistry of the life of the average individual, or what is contained in the average textbook; so there was absolute need of a selection of subject matter. The committee further recognized that there are chemical phenomena which should be understood by every person regardless of the position or occupation of that person in life. Clearly then this fundamental knowledge is the chief business of the first year study of chemistry. This knowledge should afford sufficient basis for interpreting ordinary chemical phenomena and also a basis for the further study of the subject.

The committee inquired of the section members regarding what they considered fundamental, out of a list of concepts and topics. The summary was presented at the meeting a year ago and was published in SCHOOL SCIENCE AND MATHEMATICS of March, 1920. This report was only a concensus of opinion and hence lacked the force of a precise resolution. So the committee urges the adoption of a minimum number of fundamentals stated in precise terms, as a standard course in chemistry. This list of fundamentals should not require more than 24 weeks' time to be known thoroughly, so that there may still be sufficient time left of the year to be given to topics that may be of peculiar local importance. We wish to further emphasize that what may be called fundamentals of chemistry should be thoroughly mastered by the pupil by drill and review.

It may be considered sufficient if all other topics receive only a single attention by pupils, and with this supplementary reading in the popular books pertaining to chemistry should be encouraged in every possible way.

III. *Methods of Testing Results.*

The third stage of the committee's work was taken up during the past

year. The endeavor was made to find some suitable plan of testing the results of our teaching, so that we may know beyond the mere matter of opinion as to whether we are really realizing our aims by means of the subject matter selected. A range of information test was formulated, used and compared with others of a similar nature by the previous speaker, Mr. Powers. This work should be carried forward until a standard method of testing results is obtained. This work will consolidate what has already been accomplished by emphasizing the list of fundamentals, and enabling us to see ourselves in the light of the facts in the case and not in our opinions.

Regarding the further work of a committee such as the present one we wish to state that continual reorganization (evolution) is necessary if we would progress. In realizing the first of the previously stated aims, we must keep our teaching as closely as possible to the events of life of the individual. I know of no better way to energize, or motivate our teaching than to let the pupils see and understand the value of what they are studying. It does not suffice for us to tell them that this topic or law is important. They do not doubt our word, they only do not realize it; and lacking the willpower at their age they "fall off" in the effort to master chemical relations whose value is not apparent. To speak of applications is not enough. Ideally, the teacher must create an atmosphere of reality and value in the classroom that will be as perceptible to the pupil as the atmosphere of a home differs from a hotel to any of us.

Further, if we really believe that training of the mind to solve problems is the chief business of the school rather than that of collecting facts, we will pay less attention to subject matter and more to method. Knowledge without ability to use it is vain. So we should seek less to specialize *in* our subjects, and more *on* our subjects—our pupils. We should not teach the dead things, books, at all; and the living subject less than the living pupil, whose greatest need, from the poorest child of the slums to the blasé child of the rich is to *know how to live*."

HERBERT R. SMITH,
For the Committee.

Minutes of the Geography Section.

The Geography Section of the Central Association of Science and Mathematics met Friday afternoon, November 26, 1920, at the Englewood High School, Chicago, Ill. Mr. R. R. Robinson, Acting Chairman, called the meeting to order.

The first paper entitled, "What the World Demands of Geography," was presented by Mr. F. K. Branom, Chicago Normal College. It was interesting to note that the speaker had gone to first waters of his subject by sending out questionnaires to more than sixty business concerns which employ many people. The following questions were asked:

1. Do you believe that enough emphasis is put on place geography?
2. Do you believe that some continents do not receive enough attention in the grades? If so, what continents?
3. In some schools, the geography of the eighth grade consists chiefly of (a) commercial geography and (b) a study of the home state and city in which the school is situated. Do you concede this a good plan?
4. Many pupils do not enter high school, but go to work shortly after completing the eighth grade. Do you believe that the school is training the pupil as well as it might in geography? If not, what have you to suggest in the way of improvement?

5. What are a few of the chief geographic facts or principles that a pupil should know when he completes the eighth grade?

6. According to your judgment and experience, do high school graduates have as much knowledge of geography as they should?

7. In a four-year high school where a certain number of courses are required, how many of the courses should be geography? Of what in general should each course consist? In what year should each be given?

8. In a four-year high school where electives are offered, what electives should be given in geography? Of what in general should an elective consist?

9. What have you to suggest in the teaching of geography in the high schools?

10. According to your opinion, do the average college men and women know as much about geography as they should?

11. In general, do our colleges and universities offer enough courses in geography?

From the data collected from the answers to the questions, the writer drew the following conclusions:

1. That place geography should not be neglected in the schools.

2. That in most schools, more emphasis should be placed upon South America, Asia, and Oceanica.

3. That a course in commercial and industrial geography in the eighth grade is desirable, and that the geography of the city and state should not be neglected.

4. That when a pupil leaves the eighth grade, he should have a general knowledge of geography which he may use later. The school should pay less attention to minor points and more to big problems. The subjects should be made live and interesting and too much should not be attempted.

5. That in general, high school graduates have a poor knowledge of geography.

6. That in a high school, of the required courses, two or three should be geography. One course might be the principles of geography, another economic and industrial geography and a third one commercial geography. A sufficient number of electives should be offered.

7. That the problem method of teaching geography in the grades and high school is desirable.

8. That the average college men and women have little knowledge of geography, but that many colleges are introducing courses in their curricula to overcome this defect.

9. That the business world recognizes the importance of geography. This is shown very clearly in the following letter received from a large manufacturing concern "We do, however, believe that geography is of great importance and that in the past there has not been sufficient emphasis placed upon the proper study of this subject.

"The real thorough study of place geography and of commercial geography combines with it so much of history and business, that it is almost an education in itself, and any efforts made to give more thorough training along these lines would be valuable.

"In business, particularly at the present time, the question of foreign trade is continually coming up, and it is of the greatest importance to have someone in an organization, or better yet, several members of an organization who are real experts in commercial and place geography. For this reason, if for no other, we believe it would be time well spent for anyone expecting to go into business to make an exhaustive study of this great subject."

Mr. E. C. Case of the University of Michigan next gave a talk, illustrated with slides, entitled, "The Geology and Physiography of the Semi-Arid Lands of Western Texas." He would include in any definition of geography the response of an organism to his environment. This principle he illustrated by the unfriendly red beds of Texas. Here the gypsum and salt in the soil often impart an alkali flavor to the water, already very, very scarce. The soil is easily eroded, the vegetation scant, consisting of buffalo grass, mesquite shrubs, mesquite grass and chaparal. The organism suited to this environment is the cow, and the occupation of the people who can live there is naturally that of keeping cows. Occasionally, however, there is a rainy season in this semi-arid region. At this fortunate occasion, following a rainy season, the region is advertised as excellent farming country, and homesteaders are coaxed out to the virgin territory. They plow up the soil and the majority abandon it later, for a farmer can't make his living here unless he has capital with which to tide over the fruitless, dry years. There is not rain enough to be depended on for the crops, and there is no underground water or mountain snows to supply water for irrigation. These pioneer farmers, nevertheless, have made some success in growing a hardier cotton here that resists the boll weevil. This demonstrates, furthermore, that cotton can grow further north than was previously thought, and that seeking the cooler climates for cotton may be a method in finally overcoming the boll weevil.

But the erosion of the abandoned farms, our speaker continues, ruins the region for cows. The gulleys in these abandoned farms cannot be reclaimed in fifty years, to the vegetation that once was indigenous to the region and that supported the hardy cow.

Of recent years, however, the region is defiled with oil. Derricks are over the gulleys and in the midst of the buffalo grass. After the oil, for the aftermath of oil is sure to come, is a much more cut up eroded region for the cow, this long-horn variety that could subsist with the rattle-snakes, scorpions, and tarantulas on the natural conditions of the region.

The next paper was read by Mr. Haas of Northwestern University. His subject was, "What the College Professor Should Expect of High School Graduates." Mr. Haas did not try to enumerate the facts and information especially that the high school graduate should know, but emphasized greatly that these pupils entering college should know, first of all, how to study; that they should have an open mind, ready to receive information given them; that they should know how to concentrate on the subject in hand, having conquered in previous years the mind-wandering habit.

Mr. C. E. Hamilton, of the Keystone View Company, next discussed with the aid of pictures, "The Practical Problems of Visualization in the Class Room."

Saturday morning at ten o'clock the section again met for an interesting program opened by a talk from Mr. V. C. Finch from the University of Wisconsin on "Geography for the Business Man." Mr. Finch prepared his speech with a remark that the average business man knows little about geography. He told of how a man was appointed as minister to Bogata, who asked, "Where on earth is that place?" They are four types of problems, the speaker explained, about which the business man is concerned: (a) raw material, (b) markets, (c) transportation, (d) foreign competition. Concerning raw material, the business man should know something of how it is obtained and where it comes from. Before the war, for example, manganese was brought from Russia and India. It was only learned, during the war, that it could be obtained nearer home.

In regard to foreign markets, the business man should know something

of shipping and the disposal of goods. Much is saved by having distributing centers to which large consignments of goods are shipped, and the small orders sent out from this center. The Goodrich Rubber Company, for example, has divided the U. S. into campaign sections, along geographical lines. Boston, in this division of territory is not all of Massachusetts but the part that can be easily reached from Boston, the bulk-breaking point.

Unloading conditions, also, should be studied, so that the packing may be suitable. If a consignment of merchandise is to be unloaded in Liberia, for instance, a large ocean steamer cannot reach the port. The merchandise has to be carried by small boats to shore and then carried inland on the backs of negroes. The material, undoubtedly, should be repacked on board the vessel on such occasions, in smaller packages to suit the backs of these human carriers.

Foreign competition, lastly, should be well estimated. Corn, for example from Argentina, created a stir in our own corn belt a few years ago. Anyone, understanding the resources of Argentina, however, should have concluded at first that Argentina's corn would not flood the market for all time. She can raise other crops as well as corn and her increasing animal husbandry may cause the competition of corn to be displaced by the competition of pork. Japan, in the same way, is not to be feared by the U. S. if she is understood. She has no important resources of iron or coal and could never be a formidable enemy, unless she gets Russia.

The author summarizes by saying that the business man cannot absorb enough geography in a short time to be of any service to him. There are two lines of approach, however, to this problem of bringing geography to the business man: (1) to train geographers to be assistants to business men; (2) to train the embryo man of business in geography, so that he will be furnished with geographical information to serve as a background from which to view his own business in its relation to world affairs.

Mr. H. V. Givens next presented a paper on "Some Relations Between Botany and Geography." The author selected first the Chicago area: Moranic deposits, the Chicago plain and the beach and sand dunes. Each topographic form has its own types of vegetation. This is due to the fact that the soil conditions on which plants depend are determined by the surface geology and topography, for the topographic conditions determine the exposure, the presence or absence of drainage, and the humus content of the soil. The type of plants change as the topography changes.

The author suggests a study of these changes in plant societies can best be made through the life history of a river. In a gully stage, the vertical cutting predominates over the lateral cutting. This stage is a desert one for the plant, for the exposure to wind and the alternations of temperature and moisture are excessive, and the soil is unstable. The only plants that survive are the annuals that mature between slides, or the perennials which slid down from on top. On the other hand, any plants that may grow on the steep sides prevent erosion to some degree.

As the gully widens, if left alone, a mesophytic type of forest would grow on each slope, for it is not exposed to sudden changes of temperature or moisture and the shape of the ravine tends to the conservation of moisture. The further widening of the ravine presents two conditions: one, the wearing down of the sides of the ravine, the other, building up of the valley. In the last stage, the ravine is widened out, and more drying occurs. Here we find the xerophytic type, the bittersweet and sumach. The maples of the mesophytic ravine stage are replaced by oaks.

In this way, Mr. Given caused us to feel once more the very intimate relation between botany and geography.

Following this paper, Mr. J. M. Large of the Joliet Township High School spoke to us about "Some Problems in Second Year Geography in the High School." His first problem is how to get geography more generally into the course of study. In many high schools it is not offered. This can be done, he thinks, by the selection and arrangement of suitable material in the geography courses and proper emphasis in teaching it. He reminds us of the work of the geography section in the conference of the University of Chicago and also in the conference of the University of Illinois on the content of a geography course. The method of attack of the various courses proposed by these conferences may be classed under the following headings: (1) the commerce and industry type, (2) man and his work type, (3) commercial geography with content of as many kinds as there are books, (4) vocational guidance masquerading as geography. The type that Mr. Large advocates is that of commercial geography. He thinks that vocational guidance should be relegated to civics.

The report of the Nominating Committee was now given. Mr. F. K. Branom of Chicago Normal College was elected Chairman; Mr. J. M. Large, Joliet Township High School, was made Vice-Chairman; Miss Katherine Ulrich, Oak Park High School, Oak Park, Illinois, was selected as Secretary.

Mr. Chas. C. Colby of the University of Chicago was appointed as representative of the Geography Section at the meeting for the organization of a National Council of Science Teachers.

ANNE B. ROYSTON,
Secretary.

Minutes of the Home Economics Section.

FRIDAY, NOVEMBER 26, 1920.

The section was called to order at 1:40 by the Chairman, Miss Harriet Glendon, of Lewis Institute, who made several announcements and introduced the chairman of the Program Committee, Mrs. Helen M. Sabin of Schurz High School, Chicago. Mrs. Sabin then presided during the presentation of the program which follows:

Paper, "Home Budgets and the Bank Account," Mr. Samuel Marsh, Director, The Thrift Bureau, Northern Trust Company, Chicago; Paper, "Institutional Economics," Miss Mable C. Little, Dietitian of Marshall Field and Company, Chicago. This paper pointed out the growing need for training of young women as dietitians and managers of lunchrooms in commercial establishments.

Minutes of the Mathematics Section.

The Mathematics Section held two meetings on November 26 and 27, 1920.

FRIDAY AFTERNOON MEETING.

Mr. Marquis J. Newell of Evanston, Illinois, presided.

The first paper to be presented was by Mr. Edwin W. Schrieber of the Proviso Township High School, on "The Fundamental Unit of Length in the United States." This paper was accompanied by a number of lantern slides. Mr. Schrieber traced the history of the meter from 1790, when the necessity for a uniform system was realized, up to the present time. Its use was made compulsory in France in 1837, while in 1866 its use was made lawful in the United States. The final step in the determination of the meter came when Professor Michelson's work made possible the stating of the length of the meter in terms of a constant of nature—the wave length of light from cadmium.

Mr. W. D. Reeve of the University High School of the University of Minnesota addressed the section on "The Results of Homogeneous Classification of High School Students." The grouping of the students was done by means of group tests such as the analogies, cause and effect and disarranged sentences tests. Of forty-seven high-school pupils Mr. Reeve noted that only two had an intelligence quotient of less than eighty. He asserted that we have been failing many whose intelligence quotient is above the median in the United States army. He showed the correlation between intelligence tests, including the vocabulary, omnibus, easy opposites tests, and actual performance as registered in school marks. Another method used was to make tests in the subject taught and give these to all classes. In no case has the median for the slow section equalled the median for the higher section. Mr. Reeve concluded that no school, if it can possibly afford to do otherwise, should keep the slow pupils in the same class with the highest pupils as this constitutes an injustice to both. He maintained thet the hope of the country lies in developing the highest students to the fullest extent possible.

The chairman appointed as Nominating Committee: Mr. W. H. Williams, Mr. J. M. Kinney and Mr. G. C. Staley. The chairman also appointed as Committee on Resolutions Mr. Alfred Davis, Mr. G. B. McClelland and Mr. F. C. Toutan.

Mr. C. M. Austin moved that a message of fellowship and goodwill be sent to the Association of Teachers of Mathematics of the Middle States and Maryland in session now in Baltimore and the New England Association of Teachers of Mathematics in session in Boston. The motion was seconded and carried.

Mr. C. M. Austin, President of the National Council of Mathematics Teachers, spoke on the subject of the council. He called attention to the twofold object of the organization, to keep before the educational world the value of mathematics and to improve the teaching of mathematics.

Mr. Alfred Davis moved that the Mathematics Section of the Central Association become an institutional member of the National Council. This was seconded and carried.

Mr. J. A. Foberg spoke on "The Present Work and Outlook of the National Committee as Mathematical Requirements." Mr. Foberg maintained that the real work of the National Committee is done by the men and women teaching mathematics. The promising thing about this National Committee is that it can meet and has the facilities to work with the individual teachers. Mr. Foberg stated that the report on college entrance requirements just sent to the press is the outcome of such cooperation between the committee and the instructors of subjects other than mathematics. A long list of separate items in algebra was sent to science teachers and they were asked to go through the list and check the topics which they considered important for preparation for comprehension of the elementary course in their subject. Those of absolutely no value were to be marked 0. It was found that at the top of the final list were the topics which the National Committee had urged in "The Reorganization of High-School Mathematics," and those marked 0 were the topics which the National Committee had recommended dropping. Another report soon to be issued is Professor Hedrick's report on the function concept, which has been written as an answer to the question, "How are you going to teach the function concept?" Professor Archibald's report on "Professional Training for Teachers" and Professor Smith's report on "Symbols and Terminology" will probably be considered at the next meeting of the National Council in Chicago during the last week of December. Mr. Foberg urged that all cooperate actively with the committee.

SATURDAY MORNING MEETING.

The chairman, Mr. M. J. Newell of Evanston, Ill., presided. The Nominating Committee presented the following: Chairman, Mr. W. E. Beck, Principal of High School, Iowa City, Iowa; Vice-Chairman, Mr. Alfred Davis, Soldan High School, St. Louis, Mo.; Secretary, Miss Elsie G. Parker, High School, Oak Park, Ill.

The report of the committee was accepted and the above officers elected.

The Committee on Resolutions submitted the following:

A greeting was sent in the form of a night letter to the Association of Teachers of Mathematics of the Middle States and Maryland in session now in Baltimore and the New England Association of Teachers of Mathematics in session in Boston, as follows:

"The Mathematics Section of the Central Association of Science and Mathematics Teachers sends greetings to .... A new spirit of unity among us results from the efforts of the National Committee on Mathematical Requirements and of the National Council of Teachers of Mathematics.

"We assure you of hearty cooperation in the advancement of the teaching of mathematics in the secondary schools of our country.

"Signed by the Chairman."

Be it resolved, That this section go on record as favoring a minimum requirement of four years of college or university training for all teachers of secondary school mathematics, including college mathematics through the integral calculus, and in addition, courses in the teaching of mathematics.

Be it further resolved, That instruction in mathematics be required of all pupils throughout the Junior High School, grades, 7 to 9 inclusive, and that an additional year in the study of mathematics be required of all candidates for graduation from the Senior High School.

Be it further resolved, That this section heartily endorse the work of the National Committee on Mathematical Requirements.

And be it further resolved, That we pledge to the National Council of Teachers of Mathematics our earnest cooperation.

FRANK M. TOUTON,
High School Supervisor, Wis.
GEORGE B. MCCLELLAND,
Wendell Phillips High School, Chicago.
ALFRED DAVIS,
Soldan High School, St. Louis, Chairman.
Committee.

The above resolutions were accepted by the section.

Mr. Marx Holt of Crane Junior College, Chicago, talked on the subject, "The Mechanics of the Classroom." The necessity for discussing this subject arises out of the lack of uniformity in ability among the pupils of the ordinary high school class. Mr. Holt explained in detail his use of a palm-sized card, ⅓ card index size, on which his entire system of keeping class records is based. Such a system is especially valuable in dealing with large classes. A system of committees made up of pupils is used by Mr. Holt. A consultation committee instructed in how to assist other pupils without being a crutch, a make-up committee to keep a record of assignments in order to give them to pupils who have been absent and a home-work committee to keep a record of home-work handed in have been found to be of great assistance.

A paper on "The Value of Mathematics in the High School Course"

was read by Rev. W. J. Ryan of St. Louis University, St. Louis, Mo. In this paper Reverend Ryan pointed out that the value of mathematics in the high school course would hinge on what is the chief or primary object of the high school course. He maintained that this object is cultural and hence mathematics must be taught so that the cultural value of the subject may be brought to a maximum. By the cultural value he includes all that tends to modify the pupil's point of view. He showed that while other subjects may have a disciplinary effect on character equal to that afforded by mathematics, and that while the informational value of the subject is negligible to the average student, the subject is equaled by no other in its power to change the pupils' attitudes, to give self-confidence, the method of generalizing, mental accuracy and concentration. The development of the detective instinct through the study of geometry was stressed. Reverend Ryan stated that, in spite of these great advantages of mathematics, the subject is now elective in five out of the seven courses offered in the high schools of St. Louis. However, there is now a strong movement under way to get mathematics back in the course as a required subject.

A lively discussion followed concerning the advisibility of requiring mathematics in high school and concerning the necessity for better training of teachers of the subject. Among those participating in the discussion were Mr. M. J. Newell of Evanston, Ill., Mr. F. C. Touton, High School Supervisor, Wisconsin, Mr. W. D. Reeve, University High School, University of Minnesota, Miss Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio, Miss Ethel Jaynes, Chicago, and Mr. Alfred Davis of St. Louis.

The meeting adjourned.

Minutes of the Physics Section.

Friday Afternoon Session.

The meeting was called to order by Chairman H. C. Krenerick, North Division High School, Milwaukee, Wisconsin.

The first paper was "Physics Problems Applied to Structural Engineering" by Mr. O. A. Bailey, Chief Engineer, Chicago Bridge and Iron Works. Mr. Bailey's paper was accompanied by several large drawings and charts illustrating the problems and their applications to his field. A floating brake lever of a freight or passenger car may illustrate any one of the three classes of levers, hence the arbitrary classification of levers into the well-known three classes is absurd. All such problems should be solved by the principle of moments. Problems derived from stresses in derricks, cranes, bridge and building trusses were solved by the principle of moments and triangle of forces. In this connection Mr. Bailey advocated the use of logarithms and the slide rule, also enough trigonometry to enable the student to solve the right triangle and most of the cases of the oblique triangle.

In a problem involving the strength and stiffness of beams the speaker showed why a plank supported at its ends is much stronger when set on edge than when lying flat. Other problems involving fluid pressure, hydraulic power, friction, pulleys, inclined plane, gears, accelerated motion, electric circuits, etc., followed in rapid succession.

In about an hour Mr. Bailey had convinced all present that in the field of structural engineering there are enough applications of physical principles to furnish a high school class with sufficient material for the entire year's work. To give time for the study of these applications he advocated the elimination of the study of electric cells except the dry cell and storage batteries, all of static electricity, much of the study of sound especially the mechanics of music, also about three-fourths of the time given to the study of light.

Mr. Albert E. Jeffrey, Tilden Technical High School, Chicago, had as his subject "Wireless Telegraphy as a High School Subject." Mr. Jeffrey uses wireless telegraphy as a project for teaching alternating currents rather than for the purpose of turning out wireless operators. His class is open to students who have had one year of the two-year electrical course, and to those who have had the year of physics in the four-year course. The class meets daily for a double period. Part of this time is spent in code practice, part in shop work constructing apparatus, and part in theory and problem solving. During his discussion Mr. Jeffrey demonstrated the use of resonant circuits and developed the mathematical theory relating to such circuits. The stimulus for mastery of this theory by the members of the class is the fact that they must compute the dimensions of the inductances for the short wave receiving sets they are making in the shop. At the close of his discussion Mr. Jeffrey treated the section to several phonograph musical selections furnished by Mr. Klier of station 9APP about six miles away.

Mr. J. W. Phillips, High School, West Allis, Wisconsin, had as his subject "A Wireless Telephone Transmitter." Wireless telephony is taken up in West Allis as a special project, all the time devoted to it being outside the regular school time. The transmitter demonstrated was designed for the transmission of speech and music over short distances. Blueprints of the transmitter and of the wiring diagrams were distributed to members of the section. The total cost of the outfit is about twenty dollars.

Mr. Chas. H. Smith, Hyde Park High School, Chicago, gave "A Peculiar Phenomenon of the Refraction of the Sun's Rays." A brief, interesting description of an experience of the speaker a few years ago while along the eastern shore of Lake Michigan. Looking across the lake in the evening he saw the sun set. An approaching storm from the southwest attracted his attention, then a few minutes later he was astonished to see the sun again some distance above the western horizon, thus giving the rare opportunity of seeing the sun set twice the same day.

Mr. H. C. Krenerick, North Division High School, Milwaukee, Wisconsin, gave "A Laboratory Experiment in the Driving Torque in an Automobile." For a number of years Mr. Krenerick has been using the automobile as the basis of a project in physics. He makes use of a dissected car in the laboratory and also of cars driven by the pupils. His discussion was illustrated by lantern slides.

Saturday Morning Session.

The success of the Friday afternoon program and the announcement of the program for the second session of the section again filled the room Saturday morning. The first number, "Physics in its Relation to the Manufacture and Rolling of Steel," by D. C. Atkinson, Englewood High School, Chicago, was illustrated by motion pictures. Mr. Atkinson has spent his summer vacations for the past four years familiarizing himself with the steel industry in the Gary steel mills. He has given particular attention to the countless applications of physical principles in all the processes from mining the ore to loading the finished product for shipment. The first reel showed the processes outside the mills. Archimedes' principle governs the shipment of ore in lake barges carrying 12,000 tons of ore and drawing eighteen feet of water. On the return trip these boats are ballasted with tanks of water. The machinery for unloading illustrates almost every conceivable type of lever, pulley, gears, etc., all controlled and operated electrically. The second reel showed processes in milling and rolling steel. In the entire industry very little heavy

manual labor is done; steam, hydraulic power, compressed air, and electricity have been harnessed to do the heavy work. The whole industry, except the actual smelting and open hearth process, consists of the direct application of the laws of mechanics, heat and electricity. These pictures were projected by a Zenith portable projector.

"The Project Plan in the Teaching of Physics" was given Mr. J. P. Drake, State Normal School, Emporia, Kansas. Mr. Drake emphasized the project plan for teaching physics because it supplies an "inward urge" for study. How may we heat and ventilate our homes? How may we light our homes and equip them with electrical appliances? These are projects for a month's work each. Wireless telegraphy might be used as a semester project. In Roosevelt High School, Emporia, the automobile is the project around which it is proposed to group many of the subjects and experiments formerly taught by the topic method. This plan has now been in operation for ten weeks in a mixed class of boys and girls under the direction of Prof. W. A. VanVoris.

Mr. S. L. Redman of the Central Scientific Company exhibited the Cenco Hyvac Pump and described the appearance of an electric discharge in tubes as the degree of exhaustion proceeds. This pump is a new type driven by a small motor and is capable of producing a very high vacuum in a few seconds.

Mr. Hugh Brown of W. M. Welch Scientific Company exhibited their bridge and building truss models made from balances designed to measure either compression or tension. Lantern slides were also used to show a great variety of problems in non-parallel forces that can be worked out experimentally with this apparatus.

Report of Committees on Reorganization.

I. To determine subject matter of course. Report consisting of a syllabus from the view point of life situations presented by Mr. C. L. Vestal, Chicago.

II. To supervise and suggest experiments in methods. Report presented by Mr. W. F. Roecker, Milwaukee.

III. To suggest tests to determine how far physics teachers are realizing their aims. Report prepared by the committee consisting of Prof. F. R. Gorton, Michigan State Normal, Ypsilanti, and Prof. Daniel L. Rich, University of Michigan, Ann Arbor, was read by the secretary, both members of the committee being absent (see page 275.)

The reports of the first and second committees were considered too important to dispose of without further consideration, hence were laid on the table to be taken up as unfinished business at the next annual meeting after a year of thoughtful consideration. The third committee reported that it "is not satisfied that tests can be devised which will satisfactorily determine the grade of achievement of abstract aims. . . . It is not prepared to assert that a profitable set of test questions might not be evolved which would approximate the desired end, but with the present light which they have they feel quite incompetent to submit such a test." This report was accepted.

Officers elected for the ensuing year are: chairman, DeForest Ross, Ypsilanti; vice chairman, R. G. Rupp, Hammond; secretary, John K. Skinner, Chicago.

Glen W. Warner,
Secretary.

III. Sub-Committee on Tests.

Report of the Committee on Testing the Achievement of the Teaching Aims in Physics Classes.

From reports made before the Physics Section of the Central Association a year ago, it is evident that the majority of mature teachers of physics regard as the highest aim of their work the development of the pupil's powers. By *power* is undoubtedly meant such qualities as initiative, independence of thought and action, keenness of observation, aggressiveness, etc., qualities whose value in the later life of the individual is never questioned.

In the achievement of this end, the subject matter is an effective tool. However, no one would consider it solely as a tool; but it presents material which is intrinsically of such worth that many teachers would place its mastery as the chief aim. This fact they express when they state as their aim in physics teaching the acquisition of information, knowledge of things, etc. A teacher of physics, or any science teacher for that matter, may well take pride in presenting material which is at once an efficient machine in the development of desirable powers and a compendium of useful information.

The committee appointed a year ago to devise methods for the purpose of enabling teachers to determine to what degree they are attaining the principal aims of physics teaching must beg leave to present a rather discouraging report at this time. They are not satisfied that tests can be devised which will satisfactorily determine the grade of achievement of abstract aims. Although a teacher easily becomes conscious of the effectiveness of his teaching, the committee is not convinced that any set of questions or reports can be put forth which will reveal to the mind of judges an adequate idea of the aim achievement.

A brief of this report was submitted to a group of mature physics teachers who were quite unanimous in regard to the following points by which a teacher estimates the effect of his teaching:

1. By the attention given by individuals in his classes.
2. By the interest in the subject shown in the questions raised in class; by the voluntary reports on articles read or on things which they encounter in their daily experience; the kind of reading they enjoy; by their attitude towards the popular scientific magazines, and so forth.
3. By their care in the use of apparatus and their attitude towards experimentation.
4. By their growth in keenness of observation and their ability to grasp the meaning of experiments.
5. By their ability to generalize rationally from experimental results.
6. By the growth in the power to apply general principles to new and complicated cases.

This same group of teachers was quite as unanimous in criticising adversely the proposal to ascertain these same points by a questionnaire or test. Your committee, however, is not prepared to assert that a profitable set of questions might not be evolved which would approximate the desired end, but with the present light which they have they feel quite incompetent to submit such a test for the consideration of this body.

F. R. Gorton,
D. L. Rich,
Committee.

I. SUB-COMMITTEE ON METHODS.

Report of Committee on Reorganization.

Problem: What special methods of instruction in physics will make the teaching from life situations more approachable?

Suggested Methods of Instruction.

1. *Supplementary Experiments.* To perform a series of supplementary experiments of a practical and applied nature, parallel to those regularly given, or as a summary and review at the end of each semester.

2. *Home Exercises.* To give a course in home exercises built up from material at hand in the home and the community; these exercises are to serve as supplementary work directly related to that carried on in school.

3. *Testing Station.* To make the school, through its physics department, the official testing station for the municipality and for local industries on problems which involve physical investigation.

4. *Field Trips.* To make numerous class and field trips, followed by thorough reports according to special outlines.

5. *Reference Reading.* To give supplementary work in the form of practical reference reading according to a reading list, followed by topical reports.

6. *Projects.* To teach some parts of physics in the form of projects.

7. *Visual Instruction.* To present the practical phases of the larger topics by slides and films.

Those who volunteer to give any of these methods of instruction a trial may find it desirable to base their conclusions on some tests sufficiently scientific and thorough to establish whatever merits the method may have. For this purpose, classes taught by one of the above methods should be run in parallel with others taught in the usual manner. Results may then be compared according to some acceptable standard or test.

Suggested Tests.

1. The teacher's judgment.
2. The general standings obtained by the members of both types of classes.
3. Grades obtained in a special examination consisting of twenty questions, ten of which cover the principles of the subject and ten of which involve original problems and life situations.
4. Grades obtained in a set of laboratory tests requiring the solution of practical situations by actual performance.
5. Grades obtained on a general discussion of the physics of some complex modern mechanism or utility.
6. Any standardized physics test.
7. Typical entrance examinations to colleges and universities.

Enlist now. Hand or mail your name and address to the committee and begin to contribute the information necessary in order that we reorganize the subject of physics wisely. For further information apply to your committee.

W. F. Roecker.
Boys' Technical High School, Milwaukee, Wis.
H. Clyde Krenerick,
North Division High School, Milwaukee, Wis.

Report of Sub-Committee on the Content of High School Physics.

Laboratory Methods (Pos.)

What to aim at:

1. *Verisimilitude*—natural association in pupils' minds of the apparatus and operation with real things.

2. Intermixing of laboratory work with recitation and discussion.
3. *Simplicity* and *directness*—get results without round-about methods.
4. So far as possible deduce laws from observed facts.
5. Group methods of work.
6. Some immediate utilitarian value now and then—household consultation.

Laboratory Methods (Neg.)

What not to aim at:

1. Determination of physical constants—not a course in measurements.
2. Proof (quantitative) of laws in all cases.
3. Sharp differentiation between laboratory and class work.
4. Experiment manipulated by each pupil.
5. Rigid and formal methods of demonstration.
6. Grasp of abstractions.
7. Too much reliance on lecture table demonstrations.
8. Too severe adherence to the topic under discussion.

A Physics Outline or Syllabus from the Point of View of Life Situations.

I. Mechanics of Solids:

1. Levers: scissors, crowbar, jack handles, human arm, balances, teeter-board, wheelbarrow, use of hoe and rake, claw-hammer.
2. Wheel and Axle: bicycle, auger, brace and bit, grindstone, sewing-machine drive, crank and wheel of steam engine, food grinder, clothes-wringer, automobile final drive, double gears, crank-shaft and flywheel of automobile engine.
3. Pulleys: hoists of all kinds, as painters of buildings, derricks, hoisting hay into barn, stacking hay, freight handlers' differential pulley.
4. Inclined Plane: loading slopes or skids, screws.
5. Gears: automobile gear shift, differential gear, clock gears, gears in electric meter, gas meter, water meter, worm gear, as in some auto trucks.
6. Work and Power taught by these machines: measurement of power by brake method, with small electric motor, or of hand power by turning crank, as with a bicycle. Efficiency.
7. Force and Motion: typical and common cases of components and resultants, as, for the former, the incline—a load on a hill, road and railway grades—the pendulum, the lawnmower, the sail-boat, the wind against a kite or an aeroplane. Sliding down hill, —tobogganing, ski-jumping, chute-the-chutes, scenic railway at amusement parks; accelerating an auto or a train; retardation of moving vehicles—braking power. Inertia; effects of sudden staring and stopping; momentum, as shown in colliding things, as when switching locomotive bumps cars; centrifugal force, as shown on race-tracks, baseball diamonds, railway curves, slings, merry-go-round, giant swing at amusement park, cream separator, clothes-dryer, centrifugal governor—as on steam engine or in talking machine—sparks from emery wheel or water from grindstone or mud from vehicle wheel; bursting flywheel or emery wheel.
8. Reactions: recoil of gun, rotary lawn-sprinkler; demonstrating that force is always in both directions. Gravity and center of gravity; stability; as in moving vehicles—example, limit of height of locomotive; ships' ballast; counterbalancing rotating weights, as steam engine flywheel, locomotive drive wheels, automobile crank shaft, tight-wire performers, feats of balancing by vaudeville performers.

9. Elasticity and Hooke's Law: vehicle springs, spring balances, beams for buildings, bridges, etc. Strength of material and methods of testing same. Rebound of balls, as in billiards, pool, tennis, golf, baseball football, basketball, soccerball.

II. Mechanics of Liquids:

1. Flotation: boats and ships; buoyancy on things heavier than water—the submarine; and diver; hydrometers—as used for testing acid in storage batteries, or for testing milk and other liquids.
2. Water Supply and Distribution: pressure by standpipes or elevated tanks; drop in pressure in a water-carrying pipe—as shown when many people use their lawn-hose at the same time; house-piping faucets and valves; metering; plumbing devices; drainage and sewage disposal.
3. Pumps and Pressure Devices: the ordinary lift pump; pumps as used in pumping stations; the fire-engine pump; the hydraulic ram; centrifugal pumps. Pascal's Law: the hydraulic elevator; barbers' chairs; dentists' chairs; the hydraulic press.
4. Water Power: rapids and waterfalls—potential and kinetic energy; waterwheels and turbines; little water motors.

III. Mechanics of Gases:

Air pressure; the atmosphere; lung action; pneumatic tires, pumps; bellows; air-filled balls—basketball, tennis ball, football; the barometer—atmospheric pressure; pressure and altitude—effects of mountain climbing, going to the top of a tall building in express elevator, great heights in an aeroplane. Boyle's Law: compression in the tire pump, and in the gas engine cylinder. The wind: wind turbines or "windmills." Distribution of illuminating gas—pressure and pressure loss. Distribution of water by air-pressure tank; air cushions on water system; the air chamber on force pump.

IV. Molecular Forces:

1. Adhesion: most liquids wet solid surfaces.
2. Cohesion: formation of drops; viscosity; surface tension—as shown by floating needle, and by insects walking on water bubbles.
3. Capillary Action: blotters, towels, soil taking water, wicks.
4. Solution of gases in liquids—carbonated water, ammonia, hydrochloric acid.
5. Kinetic Theory of Gases: accounting for gas pressure by molecular bombardment; temperature and molecular velocity; different rate of diffusion of different gases—as air and illuminating gas.
6. Kinetic Theory of Liquids: evaporation; rates of evaporation of different liquids—volatility; importance of volatility, as in gas engine fuel; volatility and temperature; drying clothes and the soil.

V. Heat:

1. Expansion and Contraction; thermometers—liquid and metallic; thermometer scales—F. and C.; allowance for expansion in construction work—rails, steel beams, sidewalks, timepieces; thermostatic control; expansion of air, causing air currents and winds; rise in pressure by heat, as air in heated automobile tire, expansion currents in heating a house—convection; expansion of liquids in heating by convection; review of molecular theory of expansion and pressure.

2. Specific Heat: different materials hold different quantities of heat—as iron, aluminum, copper, etc. Unit quantity of heat, the calory and the B. T. U.
3. Heating and Ventilation: meaning of ventilation; house heating-plants—hot air, hot water, steam; discussion of theory and relative merits of each; care of each kind of plant—management of fuel and ashes; relative merits of fuels—ease of combustion and heat content; radiators and "radiation;" relation between room size and radiator surface; "conductors" of heat; direct and indirect systems of steam heat; heating public buildings.
4. Refrigeration: "heat of fusion;" heat taken up by melting ice; heat of compression; artificial ice and ammonia refrigeration; making liquid air or other liquid gas.
5. Power from Heat: "mechanical equivalent of heat;" "heat of vaporization;" steam engine; gas engine; hot air engine; steam turbine. Efficiency of these machines. Factors governing efficiency. Study of the automobile engine as to construction and method of operation—carburation, heating of fuel, proper combustion; carbonization and remedies therefor; effect of engine speed on fuel mixture; effect of altitude on fuel mixture.
6. Friction: cause of friction; bearings—plain, roller, ball, with advantages and disadvantages of each; lubrication; proper weight and viscosity under different conditions; gas and steam engine lubrication; so-called "coefficient of friction."
7. Radiant Heat: colors of clothing with reference to heat—selective absorption and radiation.
8. Heat Insulation: covering steam pipes, hot air pipes, hot water pipes, with felt or magnesia; boiler coverings; insulating properties of different types of house walls; refrigerator walls; firele cookers.
9. Importance of Heat Conservation: sources of fuels; their limited supply; best forms for use; development of water power; conservation of energy; perpetual motion; transformation of energy.

VI. Electricity and Magnetism:

1. Static Charges: charge on rubber combs, fountain-pen handles, running belts, from moving feet on rugs, from fur, flannel, silk, sealing wax, fiber, glass, etc. Positive and negative charges—the electron theory; electric potential; electric capacity; electrostatic induction; insulators and conductors; condensers; atmospheric electricity—lightning, the lightning rod.
2. An Electric Current; a current, a moving negative charge, i. e., a stream of electrons; effects of this current—heat (as in the electric light), chemical action (as in batteries and electroplating), and magnetism (as in the electric bell).
3. The Electromagnet: electric bells, magnetic clocks, magnetic doorlatch, telegraph sounders and relays, spark coils, transformers, telephones, etc. The magnetic path and magnetic poles; importance of the material of the path—permeability and retentivity; the rule for polarity of electromagnet; the magnetic field around a magnet; the field around a straight wire; the right-hand rule; strength of field; the core of steel a permanent magnet.
4. Permanent Magnets: how made; uses of permanent magnets; shapes of permanent magnets, and reason therefore; the earth a magnet; the compass; usefulness of the compass; declination and magnetic maps.

5. Electrical Resistance: unit of resistance; units of current and potential difference; measurement of electrical resistance; its commercial importance; factors determining resistance; transmitting electric power; house wiring; loss of power in the wires and method of measuring and calculating this; methods of diminishing this loss.
6. Heating and Lighting by Electric Current: light only from heat; why the lamp filament gives light; amount of heat produced; kinds of electric lamps and their relative uses and merits—lamp efficiency; sizes of lamps; the gas-filled lamp. Electric cooking—toasters, grills, stoves, ranges. Other heating devices—flatirons, curling irons, soldering irons, hair-dryers. Advantages and disadvantages of electricity for heat.
7. Electricity for Chemical Uses: electroplating; hydrogen and oxygen by means of electric current—electrolysis; electrotyping; the storage battery; accidental electrolysis—as from car tracks to water or gas pipes, then vice versa; production of ozone.
8. Methods of Obtaining Electricity: batteries, various kinds; theory of the battery or "voltaic cell;" local action; polarization; the dry cell, materials and depolarization; the gravity cell; the Edison primary; life of a battery; internal resistance; groups of cells in series and parallel.
9. The Dynamo: current by "induction"; "cutting" lines of magnetic force; electric charge produced on wire; p. d. between its ends; amount of p. d., factors determining; "electromotive force"; the important characteristics of both dynamo and battery; how dynamos are rated; importance of steady voltage, and methods of regulating it; direct and alternating current; the commutator; the magnetic circuit of a dynamo; "compounding" a dynamo; dynamo speed; sizes of dynamos; methods of driving dynamos; dynamo efficiency; sources of loss of energy in the dynamo; starting the dynamo to "generating."
10. The Electric Motor: any dynamo motor at the same time; an electric current in a magnetic field; Lenz's Law; direction of the motion; amount of the force; self-regulation of the current in a motor—back e. m. f.; series and shunt motors, and their respective uses and advantages.
11. The Transformer and Induction Coil: conditions for an induced voltage; a changing magnetic field; varying the magnetizing-current; "make and break," and the alternating current; the spark coil; uses and disadvantages; efficiency; the transformer; great advantage of the closed magnetic path; commercial importance of the transformer; and the reason therefore; efficiency of the transformer.
12. The Telephone: the receiver, effect of sending a rapidly varying current through it; the voice of the speaker produces this varying current; method by which this is accomplished—the transmitter; the central exchange; party lines and multiple ringing; correct use of the telephone.

VII. Sound.

1. What is Sound: sounding things are in rapid vibration; experimental proof; speed of sound—see steam vapor from a distant whistle before hearing sound, or seeing a blow fall before hearing sound of it; factors determining speed of sound in anything; a sound wave, and how it travels; condensations and rarefactions.

2. Reflection of Sound Waves: better hearing in room than out of doors; echoes in large auditoriums; the "acoustics" of an auditorium, and what determines their character; methods of correction; absorption of sound by porous substances, like clothing, draperies, carpets, rugs.
3. Directing of Sound: speaking tubes, megaphones; proper shape of a megaphone; reflection from curved surfaces, as at the back of some stages, or bandstands; sound going around corners and edges.
4. Music: what is music? The musical scale; chords; pitch; harmony effect of pitch on brilliancy of music; present pitch numbers in music; sympathetic vibrations; resonance, as by calling certain note into piano box; vibrating strings, as in piano, violin, guitar, banjo. Factors determining pitch of vibrating strings; tuning instruments; the process of piano tuning; factors determining this. Air column instruments: the pipe-organ, horns, the flute, the clarinet. Factors determining the pitch given out by an air column; how these instruments obtain the different notes. Vibrating reed instruments; concertina, reed organ, harmonica—how they operate.
5. The Talking Machine: the record; how it is made; its surface; the sound-box, and how it operates; effect of length of needle; effect of speed of rotation of record; regulating the speed; the horn; limitations of the talking machine.

VIII. Light:

1. What is Light? How we see: reflection of light, as from a light wall surface; absorption of light, as by a dark wall surface; light a wave motion in the ether; speed of light.
2. Room Lighting: Natural lighting—size, number, and locating of windows; lighting of schoolroom—direction from which light comes; relation of window area to floor area; height of windows; tempering direct sunlight; value of direct sunlight. Artificial lighting: size, number, and location of sources; importance of avoiding glare; intensity of light; foot-candle, lumen; light measurement; the candle-power; proper kind of reflectors; floor plan showing location of lamps and switches.
3. Direct Reflection: searchlights, head-lights, mirrors; formation of images by reflection; real and virtual images; periscopes.
4. Lenses: camera, opera glasses, field glasses, telescopes, microscopes, projection lanterns, magnifying glasses, stereoscopes.
5. Color: colors of objects in sunlight and artificial light; the spectrum; mixing color pigments; color printing; color photography; color and black-and-white photography.

IX. Radio Activity:

1. Cathode Rays; X-rays; the X-ray tube; usefulness of the X-ray; X-ray pictures; method of operation; precautions; the fluoroscope.
2. Wireless transmission of energy; Hertz's discovery; an electromagnetic wave, how produced; characteristics of these waves; wave length and frequency, and their control; damped and undamped wave and methods of same; layout of sending plant; layout of receiving set; the vacuum electrode; wireless range, and its determining factors. Wireless telephony.
3. Radioactive materials; the radioactive theory.

C. L. VESTAL,
Chairman.

PROBLEM DEPARTMENT.

Conducted by J. A. Nyberg,

Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. A. Nyberg, 1044 E. Marquette Road, Chicago.

LATE SOLUTIONS.

671. *DeWitt T. Weaver, Sistersville H. S., Sistersville, W. Va.; Earl W. Martin, Wilmington College, Ohio; Walter R. Warne, Pennsylvania State College, State College, Pa.* (5 solutions).

672. *Earl W. Martin.*

673. *DeWitt T. Weaver.*

674. *William H. Brown, Amherst H. S., Mass. DeWitt T. Weaver.*

SOLUTION OF PROBLEMS.

667. *Proposed by Abigail Glenn, Student, Chicago Normal College.*

Through three given points in the same straight line, construct three lines which shall form a triangle inscribed in a given circle.

This problem was proposed in the October, 1920, issue but no solution received. *Elmer Schuyler, Bay Ridge H. S., Brooklyn, N. Y.*, has now sent in the following solution and proposes that we prove it correct.

Let A, B, C be the given points. Draw any line through B intersecting the given circle in points D and E. Construct a circle through D, E, and C, intersecting the line AC in M. Construct any circle through A and M intersecting the given circle in points I and K. Produce the line IK to intersect line AC in S. Draw tangents from S to the given circle, and let X and Y be the points of tangency. Let AY intersect the given circle again at V, and CV intersect the given circle at T. Then $\triangle$YTV is one solution. Let AX cut the given circle again at W, and CW cut the circle at Z; then $\triangle$XZW is another solution.

676. *Proposed by W. R. Warne, Pennsylvania State College, State College, Pa.*

A quadrilateral ABCD is such a one that a circle can be inscribed in it and another circle circumscribed about it. Prove that

$$\tan^2 A/2 = bc/ad.$$

I. *Solution by N. Barotz, New York City.*

By the law of cosines: $BD^2 = a^2+d^2-2ad\text{Cos}A = b^2+c^2-2bc\text{Cos}C$.

Since the quadrilateral can be inscribed in a circle, $\text{Cos}C = -\text{Cos}A$.

Hence: $\text{Cos}A = (a^2+d^2-c^2-b^2)/2(ad+bc)$.

But: $\tan^2 A/2 = (1-\text{Cos}A)/(1+\text{Cos}A)$.

Substituting the above value of CosA, and making use of the relation $a+c = b+d$ since a circle may be inscribed within the quadrilateral, we get: $\tan^2 A/2 = bc/ad$.

II. *Solution by J. Pickett, Ranger, Texas.*

Let O be the center of the inscribed circle, and OR, OS, OT, OU be the perpendiculars to AB, BC, CD, DA. Draw OA, OB, OC, OD. AB = a, BC = b, etc. $\angle$COS = $\angle$OAR since $\angle$OAR and $\angle$OCS are supplementary. Triangles ARO and OSC are similar, as are also DUO and ORB. Also OR = OS = OU.

Then $AR/OR = OS/SC$ or $OR^2 = AR\times SC$

$DU/OU = OR/RB$ or $OR^2 = DU\times RB$

Hence $$AR\times SC = DU\times RB \qquad (1)$$

Replace DU by DT and SC by CT; apply composition to the proportion, and we have $CT/RB = c/a$. Then in (1) replace AR by AU, RB by BS, and by composition we get $SC/DU = b/d$. Hence $SC^2/RB\times DU =$

$bc/ad = SC/AR$ by using (1). Also $SC/AR = OR^2/AR^2$.

Then $\tan^2 A/2 = OR^2/AR^2 = SC/AR = bc/ad$.

Also solved by R. V. Pritchard, Missouri School of Mines, Rolla, Mo.

677. *Selected.*

Prove the following theorem due to Ceva (Milan, 1678):

Lines drawn through the vertices of a triangle, and passing through a common point, determine upon the sides six segments, such that the product of three non-consecutive segments is equal to the product of the three other segments.

I. *Solution by Michael Goldberg, Philadelphia, Pa.*

Let ABC be the triangle, and AD, BE, CF the three lines passing through the common point O. Through E draw a line parallel to BC and intersecting AD at G. Then from the similar triangles we get $AC/AE = CD/GE$ and $OE/OB = GE/BD$. Multiplying, we have

$$AC \times OE \times BD = AE \times OB \times DC.$$

In the same manner we can obtain

$$AF \times CE \times OB = BF \times OE \times AC$$

And the product of these two equations is the desired relation:

$$AF \times BD \times CE = AE \times BF \times CD.$$

II. *Solution by Thomas E. N. Eaton, Redlands H. S., Cal.*

Triangle ACD is cut by the transversal BOE, and hence the relation

$$DB \times EC \times AO = BC \times EA \times DO$$

follows from the Theorem of Menelaus: A transversal of the sides of a triangle makes the product of three non-adjacent segments equal to the product of the three remaining segments. (See problem 660, November, 1920.)

Similarly, $\triangle ABD$ is cut by the transversal COF, so that

$$BC \times DO \times FA = DC \times AB \times FB$$

and from the product of these two, we get the desired result.

Also solved by *N. Barotz* by the method in I; by *R. V. Pritchard* using the theorem: two triangles having a common base are to each other as the segments into which the line joining their vertices is divided by the common base or the base produced; by *J. Pickett*, and *H. E. A. Lazott, Nashua H. S., N. H.*, using the altitudes of the various triangles; by *L. E. Mensenkamp, Freeport, Ill.*, and *Milton Kauffman, student, Wendell Phillips H. S., Chicago* using the theorem: two triangles having an angle of one equal to an agle of the other are to each other as the products of the sides including the equal angles; and by *N. Anning, Ann Arbor, Mich.*, using $BD/DC = \triangle BDA/\triangle ADC = \triangle BDO/\triangle ODC = \triangle BOA/\triangle AOC$; $CE/EA = \triangle COB/\triangle BOA$; $AF/FB = \triangle AOC/\triangle COB$.

678. *Proposed by A. Pelletier, Ecole Polytechnique, Montreal, Can.*

Prove that the square of an integer is never of the form $12n+5$.

I. *Solution by A. B. Hussey, New Rochelle, N. Y.*

Since $12n+5$ is an odd number, it can be the square only of an odd integer. Suppose $12n+5 = (2m+1)^2$. Then $12n+5 = 4m^2+4m+1$ or $3n+1 = m^2+m$. But every number, m, must be of the form $3k$ or $3k+1$ or $3k+2$. Hence

$$\begin{aligned} 3n+1 &= 9k^2+3k, && \text{or} \\ &= 9k^2+6k+1+3k+1, && \text{or} \\ &= 9k^2+12k+4+3k+2. \end{aligned}$$

The first and third of these are impossible for the right member is divisible by 3 while the left gives the remainder 1. The second is also impossible for, after subtracting 1 from both members, the left member will be divisible by 3 but not the right member. Hence $12n+5$ is not a square.

II. *Solution by Michael Goldberg.*

By inspection we see that $12n+5$ can not be an even number. Every odd number is of the form $6m\pm1$ or $6m\pm3$. Squaring the first of these gives $36m^2\pm12m+1$ or $12(3m^2\pm m)+1$; and squaring the second gives $36m^2\pm36m+9$ or $12(3m^2\pm3m)+9$. Therefore the square of an odd number must be of the form $12n+1$ or $12n+9$.

III. *Solution by Moe Buchman, Brooklyn Boys' H. S. Math. Club.*

Case 1. Let $a^2 = 12n+5$. And suppose a less than or equal to 12.

By trial of the odd numbers, we find that $(1)^2-5$ is not divisible by 12, nor 3^2-5, nor 5^2-5 etc. · · · up to 11^2-5.

Case 2. If a is more than 12, let $a = 12m+b$ where $b<12$. Then $a^2-5 = 144m^2+24mb+b^2-5$. But b^2-5 is not divisible by 12 according to case 1, and hence a^2-5 cannot be.

Also solved by Arthur H. Lord, Classical H. S., Lynn, Mass., J. Pickett, and D. T. Weaver.

679. *Proposed by several contributors during the past year.*

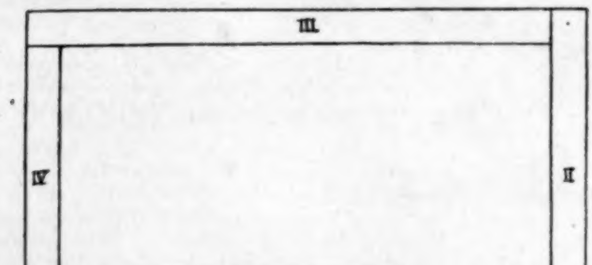
At what time past h o'clock is the minute hand m minutes ahead of the hour hand, assuming naturally that both hands move at a uniform rate and not by jerks?

The problem is a simple one as the equation is $x = 5h+m+x/12$ or $x = 12(5h+m)11$, but the comments are interesting. *A. B. Hussey* points out that $5h+m<60$ is a necessary restriction. *H. E. A. Lazott* adds that if $5h+m>60$ then the correct value of x is $12(5h+m-60)/11$; and *D. T. Weaver* explains why, namely: the equation should then be $x = m-(60-5h)+x/12$. *Donald C. Steele, Greensburg H. S., Pa.*, adds that m may be either positive or negative. *J. Pickett* gives a still more general answer: $12(5h+m)11+720n/11$ where n is any integer, for after every twelve elevenths of a revolution made by the minute hand the two hands will be in the same relative position. *I. N. Warner, State Normal School, Platteville, Wis.*, writes that the arithmetics give the following rule for such problems: multiply the hour by 5, add the number of spaces the minute hand is to be ahead and multiply the result by 12/11. An explanation by arithmetic is possible: the hands are together at 12 o'clock, and during the next 12 hours they meet only 11 times, and the meetings must occur at regular intervals, i. e., every twelve elevenths of an hour. Starting at any other except 12, the minute hand is handicapped $5h$ minutes so that $5h\times12/11$ will be required to catch the hour hand; and to get m minutes ahead $m\times12/11$ must be added.

Also solved by N. Barotz; Moe Buchman; Morris Bloom, Cicero, Ill.; T. E. N. Eaton; M. Goldberg; W. W. Ramsey, Perth Amboy, N. J.; and the following students of Redlands H. S., Cal.: Donald H. Brumbaugh, Harry T. Deming, Emmagene McMinn, Geo. C. Shinn.

680. *For undergraduates. Proposed by Norman Anning, Ann Arbor, Mich.*

If it requires 11 "rounds" of the binder to cut one-half of a rectangular wheat field and 14 more to cut the remainder, find the ratio of the length of the field to its width. All swaths are full width.



As far as algebra is concerned this is a simple problem. But few correct solutions were received, doubtless due to difficulty in understanding how a binder works. The figure below represents the field. The farmer starts his machine at A, cuts the strip I down the entire length of the field, turns to the left and cuts II, then III, IV, and is then ready to repeat starting now at B. Although the strips I · · · IV are all of differ-

HOW ABOUT YOUR SALARY CHECK?

Does it measure, adequately, the service you render?

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ent lengths, he has cut an area which is equal to the difference in area of 2 rectangles. The original area is $l \cdot w$; the part remaining after the first round is $(l-2x)(w-2x)$ where x is the width of a swath. After 11 rounds the area remaining is $(l-22x)(w-22x)$.

I. *Solution by Moe Buchman, Brooklyn Boys' H. S. Math. Club.*

Let l be the length and w the width of the field, and k the width of a swath. Then $28k = w-22k$ or $w = 50k$. Also · · · · · $lw/2 = (l-22k)(w-22k)$, which reduces to $3l = 616k$. Hence $l/w = 308/75$.

II. *Solution by Claire Aldrich, Senior High School, Adrian, Mich.*

Using one swath as a unit, the width of the field = 50 swaths. Let l represent the number of swaths in the length of the field. Then $28(l-22) = 25l$ or $l = 616/3$. Therefore the length is to the width as $616/3 : 50$ or $308/75$.

Similarly solved by Margaret Osgood, Adrian, Mich.

The first solution is easier to understand, but the second because of its use of the width of the swath as a unit of measurement is the more clever and the simpler.

PROBLEMS FOR SOLUTION.

Solutions should reach the editor by the twentieth of the following month.

667. See the statement and discussion above.

691. *Proposed by H. E. A. Lazott, Nashua, N. H.*

Divide a given line harmonically, using only a straight edge, and no compasses.

692. *Proposed by W. T. Harlow, Portland, Oregon.*

The vertices of a triangle are respectively 3, 4, and 5 feet from the center of the inscribed circle. Find the radius.

693. *Proposed by Herbert C. Whitaker, Philadelphia, Pa.*

The sides of a triangle are 4, 5, and 6; in each angle of the triangle a circle is drawn tangent to the two sides of the angle and also tangent externally to the other two circles. Find the radii of the three circles.

694. *Proposed by W. R. Warne, Pennsylvania State College, State College, Pa.*

Show that $4\sin 9^\circ = [3+\sqrt{5}]^{\frac{1}{2}} - [5-\sqrt{5}]^{\frac{1}{2}}$.

695. *For Undergraduates. Proposed by Herbert C. Whitaker.*

From a point outside an equilateral triangular field, the distances to the corners are 30 feet, 39 feet, and 62 feet respectively. What is the area of the field?

SCIENCE QUESTIONS.

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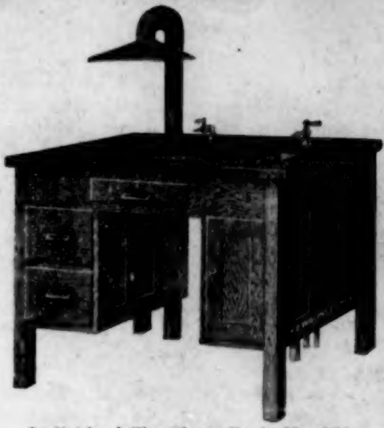

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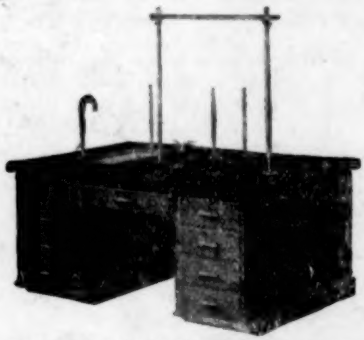

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ACKNOWLEDGMENTS.

The receipt of examination papers is gratefully acknowledged from Chancellor C. G. Jones, Education Department, Fredericton, New Brunswick; Hon. A. H. MacKay, Supt. of Education, Halifax, Nova Scotia.

QUESTIONS AND PROBLEMS FOR SOLUTION.

Tests.

Several practice tests on Mechanics have been prepared. If you would like to see copies, write to the Editor of this department.

The following have either offered to assist in standardizing tests or obtained copies of tests to be used with classes: J. O. Grimes, Supt. of Schools, Ypsilanti, Mich.; A. G. Stead, Supt. of Schools, Manistee, Mich.

Tests M_1 and M_2 were published in the February, 1921, number of SCHOOL SCIENCE AND MATHEMATICS. Please try the following tests on yourself and send in results. Suggestions for taking the tests are given in the previous number.

360. *The following test is proposed:*

TEST M_3—MOMENTS.

1. Find the moment of a force of 80 lb. about an axis 6 feet away. Ans.................

2. A weight of 2 lb. rests 1 foot from the nearest support on a bar 8 feet long supported at the ends. What are the moments about each point of support? Ans.................

3. A beam weighing 200 lb. rests with its ends on two supports 12 feet apart. A man who weighs 180 lb. walks out on the beam until he is 5 feet from the end. What is the load on each support? Ans.................

4. What is the load on each support of the following system?

A beam 22 feet long is supported 1 foot from each end. It weighs 18 lb. per foot. Loads are on the beam as follows—

200 lb. 3 feet from the left hand end;
500 lb. 3 feet from the right hand end. Ans.................

Test M_3 was tried by two persons. Times respectively were $9\frac{1}{2}$ and 11 minutes. What is *your* time?

Answers obtained—(1) 480; (2) 2, 14; (3) 175 lb. and 205 lb. (4) 428 lb. and 668 lb.

361. *The following test is proposed;*

TEST M_4. FALLING BODIES—ACCELERATION—GRAVITY.

1. A stone was dropped from a bridge and struck the water below in 3 seconds. How fast was it traveling when it struck? ($g = 32$ ft. per sec. per sec.) Ans.................

2. A body falls freely for 20 seconds starting from rest. How far will it travel? ($g = 32$) Ans.................

3. A ball is thrown just over a tree 36 feet high. How fast must it leave the hand? ($g = 32$) Ans.................

4. At the highest point in its trajectory a shell is 1600 feet above the level of the gun from which it is fired. ($g = 32$) How long is the shell in the air? Ans.................

5. An aviator leaps from a balloon in a parachute when the balloon is 3200 feet above the earth and reaches the ground in 40 seconds. What average resisting acceleration was offered to the fall of the parachute? Ans.................

Times on M_4—5: 25 minutes; 9 min.

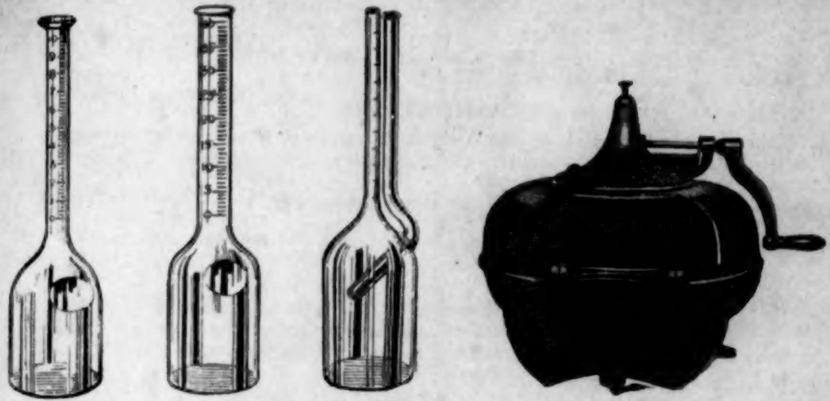
Answers obtained—(1) 96 feet per sec.; (2) 6,400 ft.; (3) 48 ft. per sec.; (4) 20 sec.; (5) 28 *ft. per sec.* per sec.

Try this test on yourself. What is *your* time?

361. *Proposed by Isaac R. Ross, Broken Bow, Nebraska.*

Which is the more active, chlorine gas or oxygen?

(Mr. Ross says, "This question has aroused a great deal of interest on our class. References given on the two elements seem to contradict themselves."



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EXAMINATIONS.

This is a continuation of the Alberta examinations of which the Agricultural paper was published in the February, 1921, number of SCHOOL SCIENCE AND MATHEMATICS.

362. *Ninth Grade Departmental Examinations in Botany and Zoology.* [*Comments are desired.*]

Time—Two and one-half hours.

BOTANY.

Values.

1. (*a*) Describe the flower of a plant belonging to either the *Rosaceae* or *Cruciferae* order, giving:

4 (1) Description of each part of the flower;

4 (2) The functions of each part;

2 (3) A drawing of one half of the flower to show the relation of the parts.

2 (*b*) What are the leading characteristics of the order to which the plant selected in (*a*) belongs?

4 2. (*a*) Define and give an example of each of the following: pome, drupe, silique, capsule.

10 (*b*) Select any *five* of the following plants and state in each case (1) the natural agent by which its seed is disseminated; (2) its adaptation for dissemination: Cottonwood, ball mustard, great willow herb, wild cherry, poppy, shepherd's purse, wild raspberry, Russian thistle.

5 3. (*a*) Describe, giving drawings, the stages in the germination of a bean until the first pair of leaves has developed.

4 (*b*) In what respects does the germination of (1) the wheat, (2) the pea differ from that of the bean?

4 (*c*) Classify as to form the roots of the following: dandelion, wheat, lawn grass, shepherd's purse.

4 4. (*a*) Distinguish pinnately and palmately compound leaves and give an example of each.

4 (*b*) Name two types of venation in leaves and illustrate each by means of a drawing.

3 (*c*) Describe, giving examples, three methods of leaf arrangement with a view to securing good exposure to sunlight.

OR

3 (*d*) Describe, giving examples, three methods by which plants are adapted for climbing.

ZOOLOGY.

5. Write a note on the grasshopper, giving:

4 (*a*) Description of the legs, showing how they are adapted for clinging and jumping.

4 (*b*) Description of each pair of wings and the function of each pair.

4 (*c*) Its enemies and how it is adapted to escape them.

6. (*a*) Write a note on the life history of a butterfly or moth that you have studied, giving:

2 (1) Time when and place where the eggs are deposited;

2 (2) Food habits of the larva;

2 (3) The period during which it remains in the pupa stage;

4 (4) Distinctive markings of the adult.

6 (*b*) Compare the wings of the butterfly or moth with those of the beetle and bee as to number, structure and function.

4 7. (*a*) Distinguish between complete and incomplete metamorphosis, illustrating your answer by reference to insects studied.

2 (*b*) Give two examples of insects which are aquatic in the larval stage.

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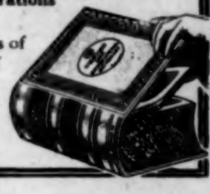

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4 (c) Give two examples of (1) injurious, (2) beneficial insects, stating in each case the injurious or beneficial work done by the insect.

4 8. (a) Make a drawing of any common spider showing the body parts and appendages. Name the parts.

4 (b) How does the spider spin its web? What is the chief use made of it?

4 (c) In what respect does the spider (1) resemble, (2) differ from an insect?

OR

6 (a) Make a drawing of a common fresh water snail with body extended. Name the parts.

3 (b) Describe its mode of locomotion.

3 (c) By reference to its food habits, show why a few should be kept in a school aquarium.

100

363. *Examination in Physical Science.*
[*Comments are desired.*]

Time—Two and one-half hours.

Values.

4 1. (a) State two important advantages gained from using the metric system of units.

4 (b) Find the capacity in litres of a rectangular vessel the inside dimensions of which are: length 80 cm., width 55 cm., depth 25 cm.

8 2. (a) Define or write explanatory notes on: Force, energy, centre of gravity, momentum.

6 (b) Describe an experiment to show how the centre of gravity of a triangular sheet of cardboard may be determined.

6 3. (a) Show by reference to the lever and pulley two advantages which may be obtained through the use of machines.

6 (b) What is the mechanical advantage of a windlass if the diameter of the axle is 6 inches and the length of the crank is 15 inches?

8 4. (a) How may the Principle of Archimedes be demonstrated experimentally?

4 (b) A mass of iron weighs 35.3 grams. When immersed in water it appears to weigh 30.3 grams. Calculate its specific gravity.

8 5. (a) Show by means of an experiment how the rate of pressure of the atmosphere may be measured.

12 (b) Describe, using diagrams, the construction and action of a suction or lift pump and show how the height of the piston above the surface of the water in a well is related to the rate of pressure of the atmosphere.

10 6. (a) Describe an experiment to demonstrate that the rate of pressure in a liquid varies as the depth and is independent of the shape or diameter of the vessel containing it.

8 (b) State and illustrate by a diagram the conditions under which an artesian well may be obtained.

7. Select any *four* of the following questions:

4 (a) Why is it more difficult to lift a barrel of flour to a platform than to roll it up a plank?

4 (b) A glass of water is being weighed on a balance. If a small body is suspended in the water, why does the glass of water appear to be heavier?

4 (c) Why is a soap bubble spherical in form?

4 (d) One end of a towel is placed in a basin of water. Why

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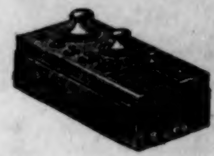

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does the part of the towel above the surface of the water become wet?

4 (e) What practical application has been made of the fact that air exerts a buoyant force?

4 (f) Why does a wet paper adhere readily to a window pane?

100

SOLUTIONS AND ANSWERS.

350. *From an examination in* DYNAMICS *of the Scottish University Examination Board, March, 1919.*

The arms of a balance are unequal in length. If a mass appears to weigh 25 grammes when placed in one scale pan, and 24 grammes when placed in the other pan, find its real weight, if the weights of the arms and the scale pans may be neglected.

If the arms are equal but the scale pans are of different weights, and the mass seems to weigh 25 grammes and 24 grammes, in the respective pans, find its real weight.

Solution by L. R. Burlin, 3d year apprentice, The Warren & Swasey Co., Cleveland.

When arms are unequal

Let w = wgt. of object.
l_1 = short arm.
l_2 = long arm.

1st case, with wgt. in l_2 pan,

$$w \times l_1 = 25 \times l_2.$$

2d case, when w is *placed* in short arm pan,

$$w \times l_2 = 24 \times l_1.$$

$$w = \frac{25 \times l_2}{l_1},$$

so

$$w \times l_1 = 25 \times l_2$$

therefore

$$\frac{l_1}{l_2} = \frac{25}{w}$$

substituting

$$w = \frac{24 \times l_1}{l_2}$$

$$w = \frac{24 \times 25}{w}$$

$$w^2 = 600$$

$$w = \sqrt{600}$$

$$w = 24.4949 \text{ grams}$$

When arms are equal, pans different wgts.

Let m_1 be the lighter pan
m_2 be the heavier pan

1st case, if w is placed in light pan—

$$(w+m_1)l = (m_2+24)l.$$

2d case, if w is placed in heavy pan—

$$(w+m_2)l = (25+m_1)l,$$

dividing by l,

$$w+m_1 = m_2+24,$$

$$w+m_2 = m_1+25,$$

adding,

$$2w = 49,$$

$$w = 24\tfrac{1}{2} \text{ grams actual wgt.}$$

351. *From the same examination in* DYNAMICS.

Three weights of 1, 2, and 3 lbs. respectively are placed at the angular points A, B, C of an equilateral triangle. Find the perpendicular distance of their common Centre of Gravity from the side BC when the side of the triangle is 2 ft.

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Solution by R. T. McGregor, Elk Grove, Cal.

The c.g. of the 1 lb. and 2 lb. weights lies on AB 8″ from B. At this point a 3 lb. weight may be supposed to be hung. The c.g. of this 3 lb. weight and the 3 lb. weight at C lies on the join of the first c.g., and C at its midpoint. Let this midpoint be denoted by P, and the foot of the perpendicular from P on BC be denoted by E. Then it may easily be shown that PE $= 2\sqrt{3}$ in.

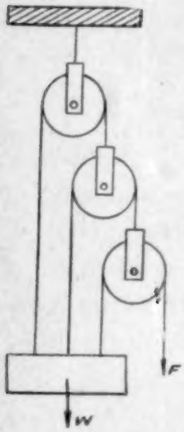
353. *From the same examination in* DYNAMICS.

[*Why is this not a fine test question? Just what would it test?* EDITOR.]

(*a*) Make a drawing of a system of three pulleys in which the strings are attached to the weight; and find the relation between the power and the weight.

(*b*) If each of the three pulleys weighs 2 pounds, find the weight raised if the power applied be 16 pounds weight.

Solution by K. L. Pohlman, Cleveland, Ohio.



(*a*) The accompanying diagram shows one manner in which the strings can be attached to the weight. [*Is there any other manner?*]

The relation between f and w would then be (the weight of the pulleys and rope and friction being neglected) $\frac{f}{w} = \frac{1}{1}$.

The only advantage would be a change of direction for the applied force f.

(*b*) If in the above problem f be equal to 16 lbs. and the weight of each pulley be 2 lbs. (friction and weight of rope neglected)

$$w - (2 \times 2) = 16$$

and

$$w = 20 \text{ lbs.}$$

[*Query*—What are the *tensions* in the parts of the ropes?]

GEOLOGIC EXPLORATIONS FOR ASBESTOS.

The United States now obtains most of its high-grade, long-fiber asbestos from Canada, but geologists of the United States Geological Survey hope that large deposits which will yield material of good quality may yet be found in the Western States, especially in Arizona, where asbestos of unusually long fiber and silky texture has been discovered.

In the Apache and San Carlos Indian reservations, in Arizona, asbestos, is found associated with rocks known by geologists as the Apache group, which is made up of several formations. The principal deposits are in the Salt River region, where the Apache group is represented chiefly by beds of quartzite and limestone, which are at many places invaded by diabase, an igneous rock. Throughout this area much diabase has been injected into beds of limestone, and the asbestos is found near the contact of the limestone with the diabase. Places where the limestone has been much broken by diabase have been particularly favorable for the formation of asbestos. The asbestos is invariably associated with serpentine, a greenish mineral that is in some deposits in other regions mottled like a serpent's skin, and although serpentine occurs at many places without asbestos, serpentine "float" fragments of it that lie loose on the surface, having been washed out from its outcrop, are a valuable aid to the prospector for asbestos. In this region asbestos itself is also generally found as float for a considerable distance below its outcrop.

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BOOKS RECEIVED.

Dynamic Americanism, by Arnold B. Hall, University of Wisconsin. 335 pages. 13×19.5 cm. Cloth. 1920. Bobbs-Merrill Company, Indianapolis.

Elementary Home Economics, by Mary L. Matthews, Purdue University. Pages xx+343. Cloth. 1921. Little, Brown and Company, Boston.

Types of Mental Defectives, by Martin W. Barr, Penn Training School for Feeble-Minded Children, and E. F. Moloney, Girard College. Pages ix+179. 16×24 cm. Cloth. 1920. P. Blakeston's Son and Company, Philadelphia.

Report of the Commissioner of Education for the Year Ending June 30, 1920. 134 pages. 14.5×23 cm. Government Printing Office, Washington.

The State Board of Education. Our Agency of Cooperation and Coordination. The First Year of Wisconsin's Educational Bonus Law, 1919-1920. Wisconsin Looking Forward, An Educational Program. State Board of Education, Madison, Wis.

Fire Prevention in Illinois Forests, by Robert B. Miller; Bureau of Educational Research, by B. R. Buckingham. University of Illinois Press, Urbana, Ill.

Department of the Interior, Bureau of Education, the following Bulletins:

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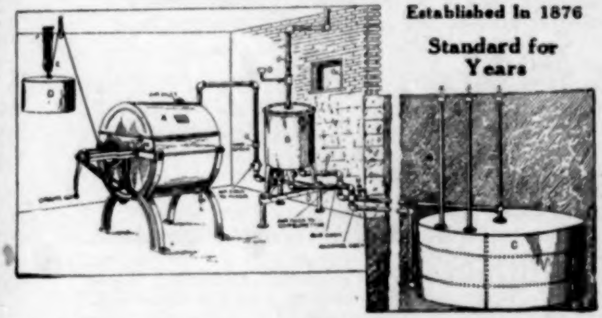

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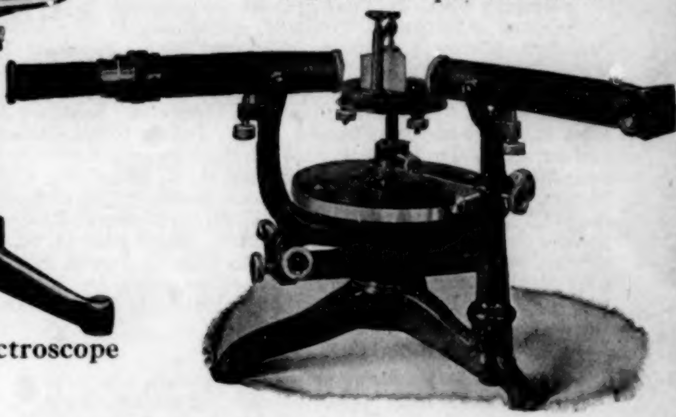

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